# MECHANICAL ENGINEERING

November 1956

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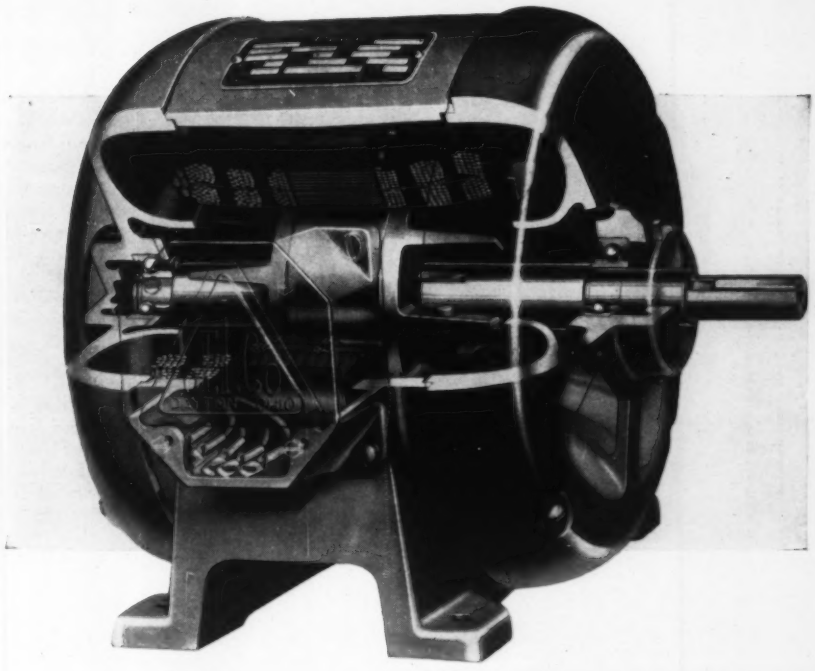

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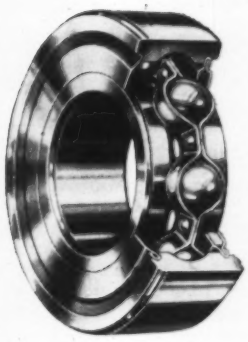

Precision-made New Departure ball bearings assure permanently accurate support of the rotor shaft under all load conditions and mounting positions, plus cool-running, quiet bearings at all speeds.

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GM GENERAL MOTORS

NOTHING ROLLS LIKE A BALL


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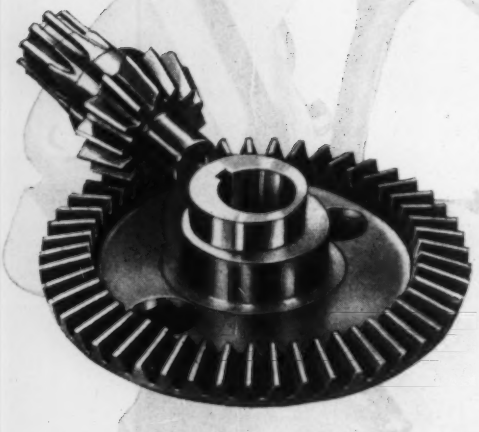

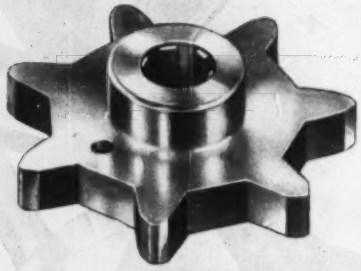

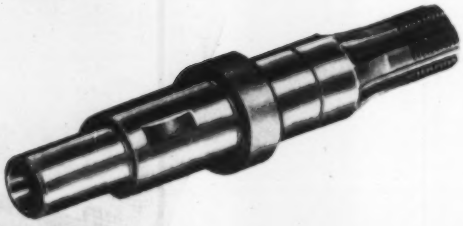

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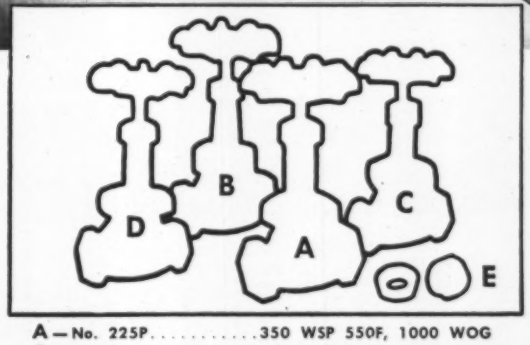


A — No. 225P.....350 WSP 550F, 1000 WOG
B — No. 260P.....300 WSP 550F, 600 WOG
C — No. 245P.....200 WSP 550F, 400 WOG
D — No. 237P.....150 WSP 500F, 300 WOG
E — "500 Brinell" Stainless Steel Plug Type Seat and Disc

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• **Bodies,** made of Composition M bronze (ASTM B61), have ample wall thickness to provide high safety factor.

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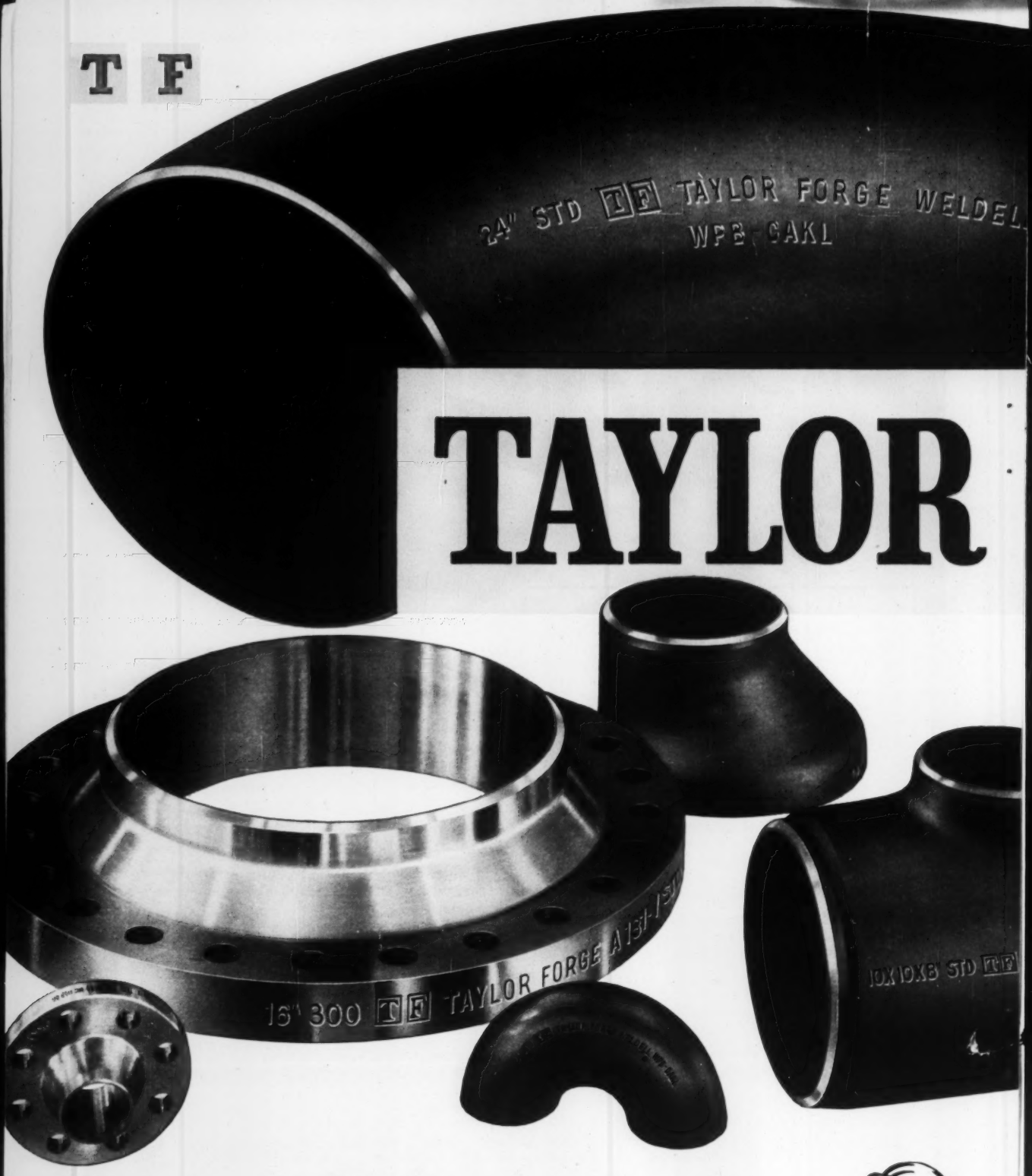
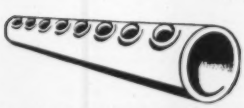
# TAYLOR



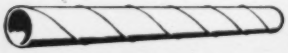
Welding nozzles

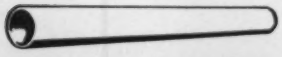
T.E.M.A. flanges and channels


Multiple outlet headers

Production forgings

Venturi reducers


Spiral weld pipe


Large diameter electric weld pipe

Welding necks

# By any method of value analysis...
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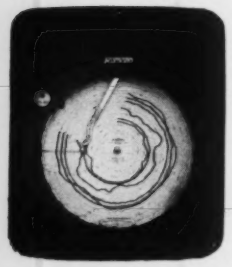
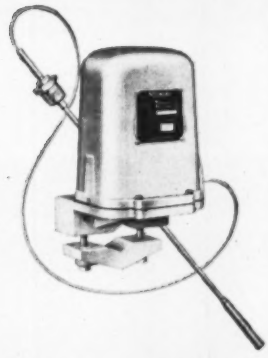


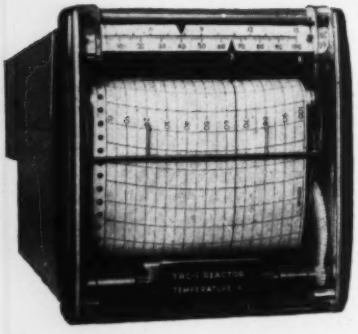
## Dynalog Electronic Instruments

Complete line of indicators, recorders, and controllers employing the advanced Dynalog measuring system in which a friction-free air capacitor replaces conventional slide-wire — provides continuous, stepless balancing action. Dynalog Instruments provide up to six records on a single round chart. For use with resistance or voltage type primary elements — pneumatic or electric control action.

## Multi-Record Dynalog

- 6 color-coded temperature records on one round chart.
- Each record line a distinctive, non-smudging color.
- No slidewire — no batteries — no standardizing.
- Thermocouple or resistance bulb types.





## Consotrol Recording Control Station

One of the complete Consotrol line of compact panel indicators, recorders, and controllers. This advanced control station features full 4" chart and scales, six-months' ink supply, bumpless auto.-man. transfers. The M/58 Consotrol Controller, shown here integrally mounted, provides:

- All four control actions, with two reset ranges, easily adjustable to widest variations in operating conditions.
- Easy lever-setting proportional band, calibrated to 500%.
- High sensitivity and precision due to unique "floating disc" balancing action — even at widest settings of proportional band.
- Interchangeable "plug-in" components.
- Continuously variable reset resistance gives 500:1 rangeability.

## PRIMARY ELEMENTS

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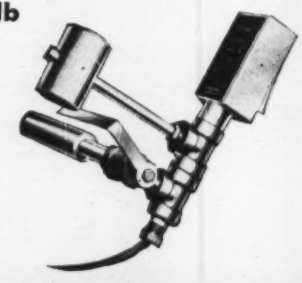
## Dynatherm Resistance Bulb

For use with Dynalog Electronic Instruments.

- Superior measurement performance for temperature up to 600°F.
- Fastest response due to positive metal-to-metal end contact with standard wells or sockets.
- Highest sustained accuracy. Permits use of extra-narrow scales — ideal for precise temperature difference measurements.



## Roll Surface Temperature Element

- Continuous, automatic measurement or control of roll surface temperatures up to 450°F.
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**from −450°F to +2800°F**

## Model 12A Temperature Pneumatic Transmitter

- Simple way to measure remote temperatures in the −100°F to +1000°F range. Operating spans of 50°, 100°, 200°, and 400°F.
- Compensated for ambient temperatures and pressures.
- Compact, easily installed. Uses regular ¼" O.D. tubing transmission lines — no troublesome conduits, no costly capillary tubing.
- Suitable for any hazardous, corrosive, or outdoor location.

## Electric Proportional Action Controller

- Can be used with any Foxboro measuring system — mechanical or electrical.
- Precise, frictionless control action through electronic relay and electric valve operator.
- 3 types of proportional control action available.
- Setting knob permits easy, stepless adjustment of control band throughout range of instrument.

Whenever you have a temperature problem in the −450°F to +2800°F range, you can depend on Foxboro Instrumentation for the best solution. Foxboro's outstanding combination of truly advanced instruments and unequaled experience in applying them, has successfully solved temperature problems as widely different as helium liquefaction and jet engine testing. Foxboro offers a wide variety of primary elements, transmission devices, indicators, recorders, and controllers. Whether a single instrument or a combination is required — filled-system, electronic, or electric — you can be sure of fitting the process *exactly*. Unique Foxboro developments, such as Dynalog* Electronic Instruments, Dynatherm** Resistance Bulbs, and the 12A Temperature Transmitter, continually maintain control standards in step with every advance of modern processing. A few of the instruments which typify Foxboro's better-engineering are shown on these pages. Chart below shows complete temperature ranges covered by Foxboro measuring systems. Write for complete details. The Foxboro Company, 9611 Neponset Ave., Foxboro, Mass.

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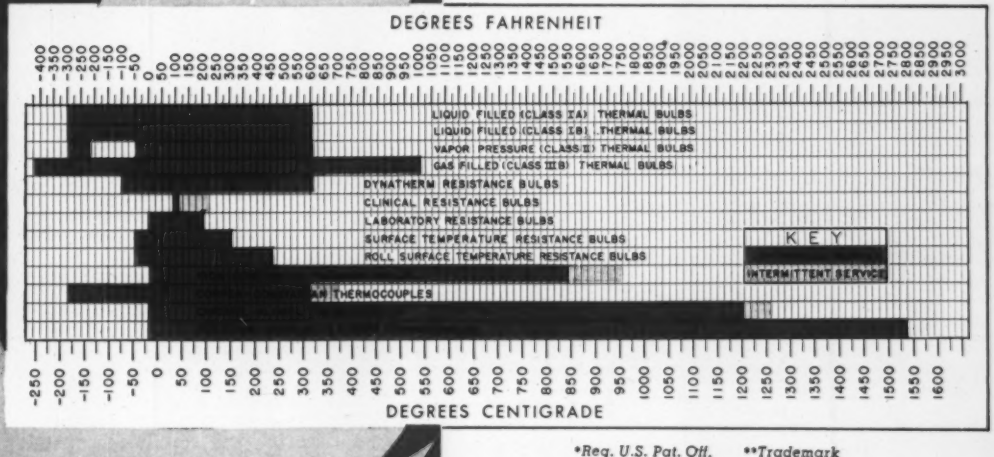
**TEMPERATURE measurement and control**

**Locate your problem temperature in this table**

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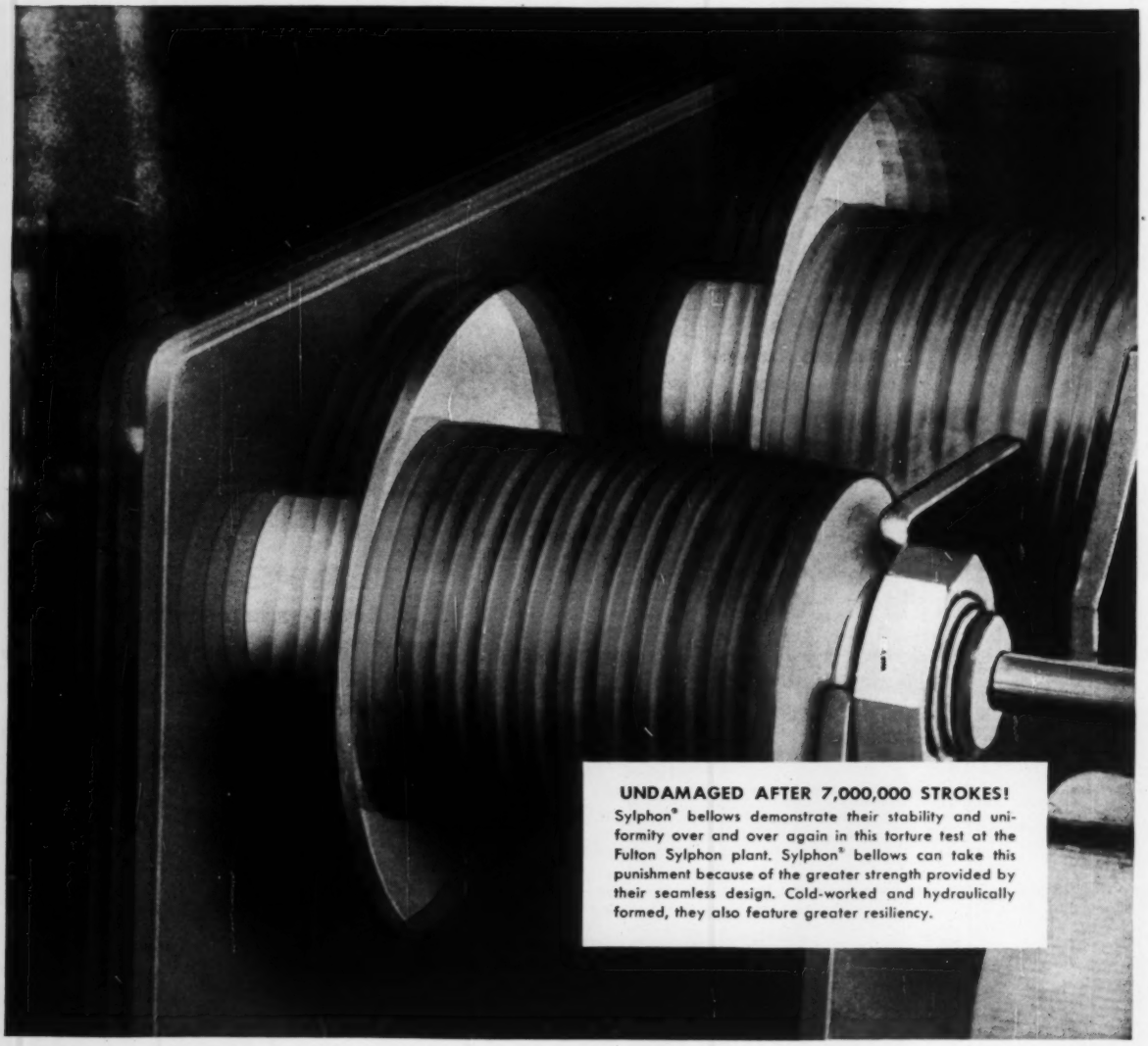
FULTON SYLPHON

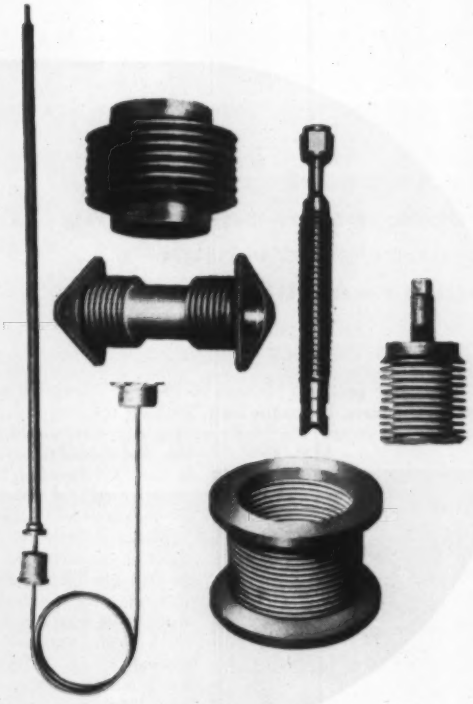
# BELLOWS ASSEMBLIES

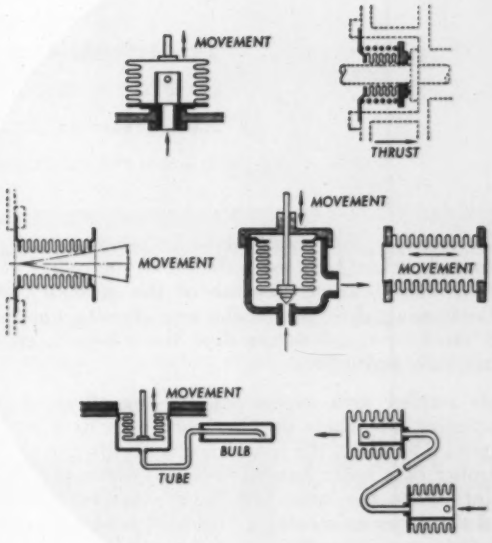
With Fulton Sylphon *complete* bellows assemblies, you get added assurance that all their dimensional and operating accuracy will be retained in guided missile, aircraft, nuclear power, and other torturous applications. A wider-than-ever choice of standard and special metals now enables you to obtain unmatched uniformity and long-term stability even with constant cycling or extreme temperature and pressure conditions. Whatever the metal . . . whatever the bellows function . . . you also get the benefit of big cost savings by letting Fulton Sylphon produce the assembly complete with bellows and all accessory parts.



**UNDAMAGED AFTER 7,000,000 STROKES!**
Sylphon® bellows demonstrate their stability and uniformity over and over again in this torture test at the Fulton Sylphon plant. Sylphon® bellows can take this punishment because of the greater strength provided by their seamless design. Cold-worked and hydraulically formed, they also feature greater resiliency.

# offer longer life in a wide range of metals



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Whether they're to be used in the most delicate instrument or the most rugged equipment, Fulton Sylphon bellows assemblies are fabricated in the best metal for the application . . . brass, phosphor bronze, copper, beryllium copper, monel, stainless steel and other appropriate metals to suit the job. For added protection against extremely high pressures, strength of the metal itself can be multiplied by forming the bellows in multiple plies. Special solders or welded construction also are available to make the entire assembly uniformly resistant to temperatures up to 500°F. and higher.

### ASSEMBLIES IN MANY DIFFERENT DESIGNS!

The accuracy, stability, and uniformity of Fulton Sylphon bellows assemblies can be used advantageously in converting or absorbing temperature or pressure effects; absorbing expansion, shock or vibration; sealing shafts and joints; and performing many other functions. Instead of buying bellows and assembling them yourself, let Fulton Sylphon do it. With its highly specialized facilities and fabrication experience, Fulton Sylphon can invariably save you money by producing the assembly complete with ends, brackets, flanges, tubing, bulbs, or other accessory parts.

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# Cylindrical Roller Bearing Inner Races

**Their vital importance in bearing performance . . . advantages of carburizing . . . the manufacturing procedures which assure maximum quality and life**

The function of an inner race is to provide a fatigue-resistant surface between a shaft and the rollers of an anti-friction bearing. Because of the geometry of a roller bearing, there is a smaller area of contact between the inner race and rollers than there is between the outer race and rollers.

This smaller area of contact has the effect of concentrating the loads on the inner race to a greater degree. Therefore, the inner race is always the critical member of a roller bearing from a fatigue life standpoint. When the inner race is the stationary member and the outer race rotates, this load concentration on the inner race is even more of a factor since the maximum load is repeatedly applied at one point.

Adequate resistance to relative movement between the inner race and shaft is vital to satisfactory performance. HYATT inner races are made of materials chosen to permit relatively heavy press fits. When HYATT press fitting recommendations are followed, the inner race becomes an integral part of the shaft for all practical purposes.

## 1. WHY CARBURIZING?

HYATT inner races are made of a good *carburizing* grade of steel, rather than through-hardened steel, for several reasons. First, carburizing permits the vital heavy press fits referred to above. Second, tough flanges that will not break out under impact can be obtained on carburized races with no loss of case hardness. Third, carburizing improves load-carrying capacity, as shown in Diagram A. During quenching, the phase change from austenite to martensite which occurs in the outer case is accompanied by a volumetric change; but the low carbon core remains tough and ductile *without* appreciable volumetric change. The result is a tendency to stretch the core and compress the case. Due to the Poisson effect, *the compressive hoop stresses in the external fibres build up the load-carrying capacity of the race.*

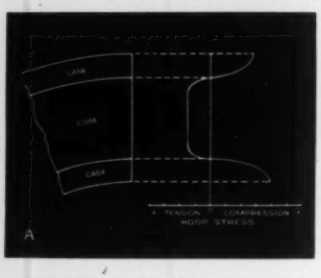
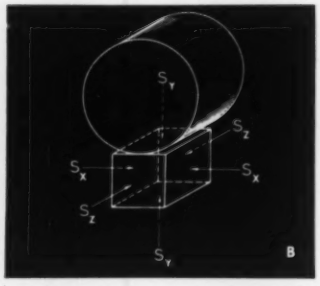



Diagram B shows a typical element of a HYATT carburized inner race under roller load. Stresses in the "Z" direction are negligible. Stresses in the "X" direction are compressive hoop stresses or preload. Stresses in the "Y" direction are compressive stresses due to the load. Without the compressive stress Sx (hoop stress) the load-carrying capacity would be less; and should the stress in the "X" direction become a tensile stress due to pressing a through-hardened race on a solid shaft, the capacity would be still further reduced. Reference to applicable theories of material failure will support this view and indicate why HYATT has gone to substantial added expense to give customers the benefits of carburized inner races.




## 2. OPERATIONAL REQUIREMENTS

A top-quality inner race should have all the following characteristics:

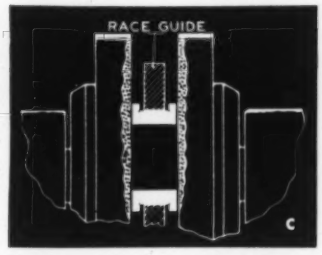
1. *Minimum wall variation:* Concentricity of the inner race pathway to bore is necessary for quiet operation at full bearing capacity.
2. *Minimum runout of race ends to bore:* The bearing must not be cocked on the shaft by location against a square shoulder with a race end having excessive runout.
3. *Minimum runout of race flange inner faces to bore:* Excessive flange face runout results in noisy operation and hunting of the shaft.
4. *Minimum bore tolerance:* An important fitting consideration. If all the available tolerance is taken in the race bore, the shaft tolerance is unnecessarily restrictive.
5. *Minimum pathway and bore taper:* Taper causes uneven roller loading with resultant overheating and poor life.

## 3. MANUFACTURING PROCEDURES

Good control of primary machining is reflected in good quality of the finished product. The early stages of manufacture, through the heat treating operation, are highly important and are all scrupulously controlled by HYATT. In this article, however, the *finishing operations* are of primary interest and will be discussed in detail.

Centerless grinding operation on a large Hyatt inner race.

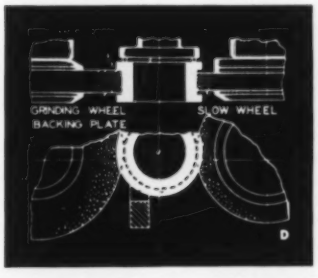
## 4. DOUBLE END GRIND




The sequence of grinding operations is important. The ends must first be faced off *square and parallel* so that during subsequent operations the ends can be used as accurate reference. The HYATT double end grind operation illustrated in Diagram C insures excellent control of race end parallelism.

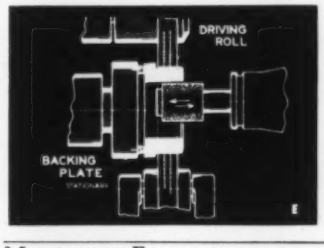
## 5. CENTERLESS PATHWAY GRIND

The centerless grinding principle was pioneered by HYATT many years ago. This method was a significant improvement over existing chucking methods because it eliminates excessive wall variation introduced by spindle and chucking errors.



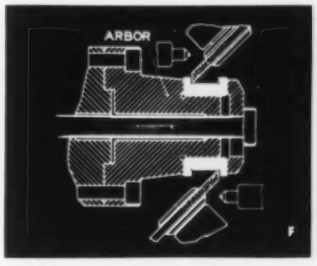

The race pathway is ground by the centerless method to produce a race with as nearly a perfectly round diameter as is commercially practical. Two-point and three-point out of round as well as taper are held to a minimum. Note that the work is rotated with a backing plate against the previously ground end, as shown in Diagram D.

## 6. CHUCKLESS BORE GRIND




Here again the centerless method is employed to generate an inner diameter (bore) concentric with the outer diameter (pathway.) This is accomplished by driving the race on the outer diameter and positioning the grinding wheel relative to the drive roll. The result is maintenance of minimum wall variation by removing stock from the high spots as they pass between the drive roll and the grinding wheel, as shown in Diagram E.

## 7. FLANGE GRINDING




All flange faces must be ground to run true with the roller pathway. Since the pathway and bore have been ground using the ends as a reference, the ends are also used as reference while grinding the flange faces (Diagram F). This establishes all-important even contact with the roller ends during operation of the bearing.

## 8. VIGILANT INSPECTION

Strict inspection is vital to the maintenance of high-quality standards in a precision product such as roller bearings. Working with the finest test equipment under conscientious supervision, highly trained HYATT inspection teams constantly watch the quality of HYATT parts as they are produced. This insures traditional HYATT dependability.

### YOU WILL FIND FURTHER DETAILS

in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type of cylindrical roller bearings best suited to your design requirements. Remember, HYATT is America's *first* and *foremost* maker of roller bearings. Hyatt Bearings Division of General Motors Corporation, Harrison, New Jersey.

GM GENERAL MOTORS

# HYATT

**HY-ROLL BEARINGS FOR MODERN INDUSTRY**

# A New Concept In Boiler Cleaning . . . "GROUP CONTROL"

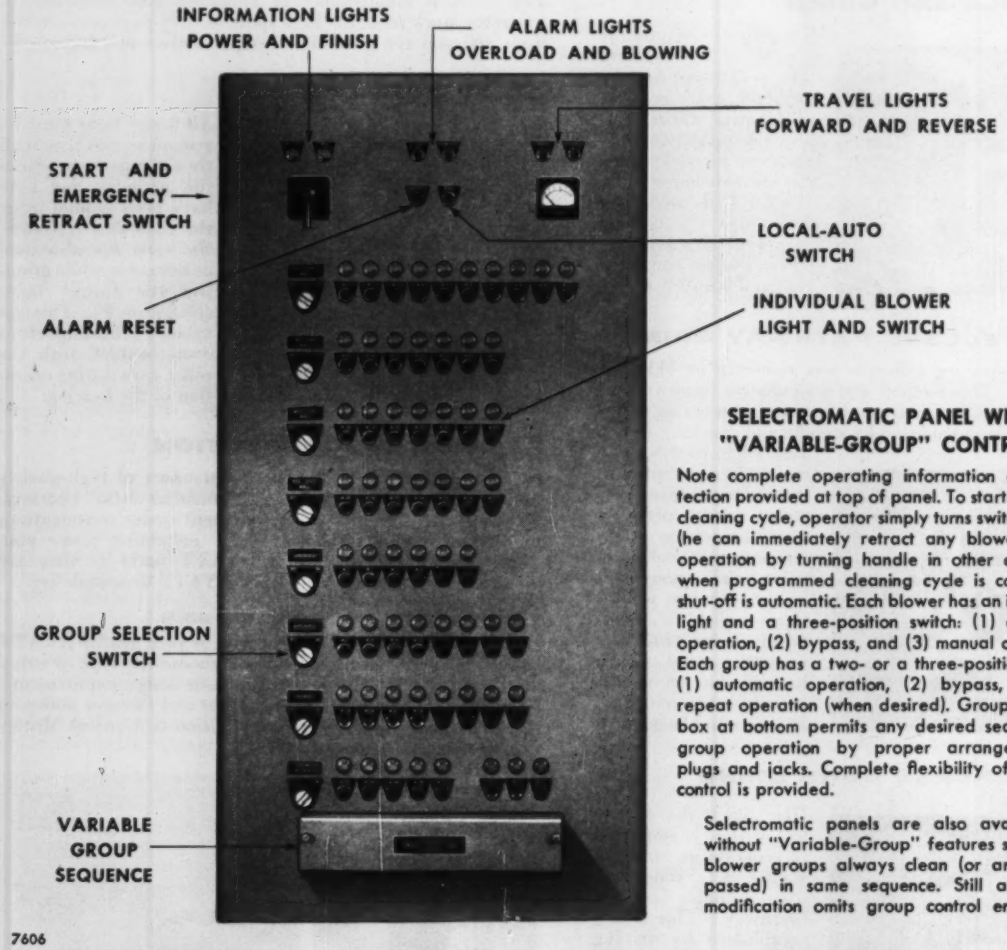
## with Diamond SELECTROMATIC* PANELS

GROUP CONTROL, is designed to accomplish more direct operation of *functional groups* of blowers rather than individual units. Group control is applicable where there is a large number of furnace wall, superheater, reheater and economizer cleaning units which rarely warrant blowing by single units but can rather be operated in groups representing each level of such blowers.

The Group concept can readily be arranged to have physical similarity to the boiler unit itself, with the groups starting at the lowest furnace level and progressing upward through the furnace wall blower levels and on through the superheater and reheater banks, economizer and air heater in logical group sequence.

A Diamond Selectromatic* Panel will provide the flexible blower control needed for the most efficient, economical and dependable cleaning of ANY boiler. The automatic sequential operation is easily and quickly changed to meet variable cleaning conditions in the unit. Operators know at all times the operating conditions of the blowers (see top of left page). Protective devices include automatic blower retraction on motor overload, blowing medium failure, and current failure (after restoration). Once a cycle is selected and initiated by the operator, no further attention is needed.

*Selectromatic is a registered trade mark that is a contraction of the functional features of these controls: selective—electric—automatic.




7606

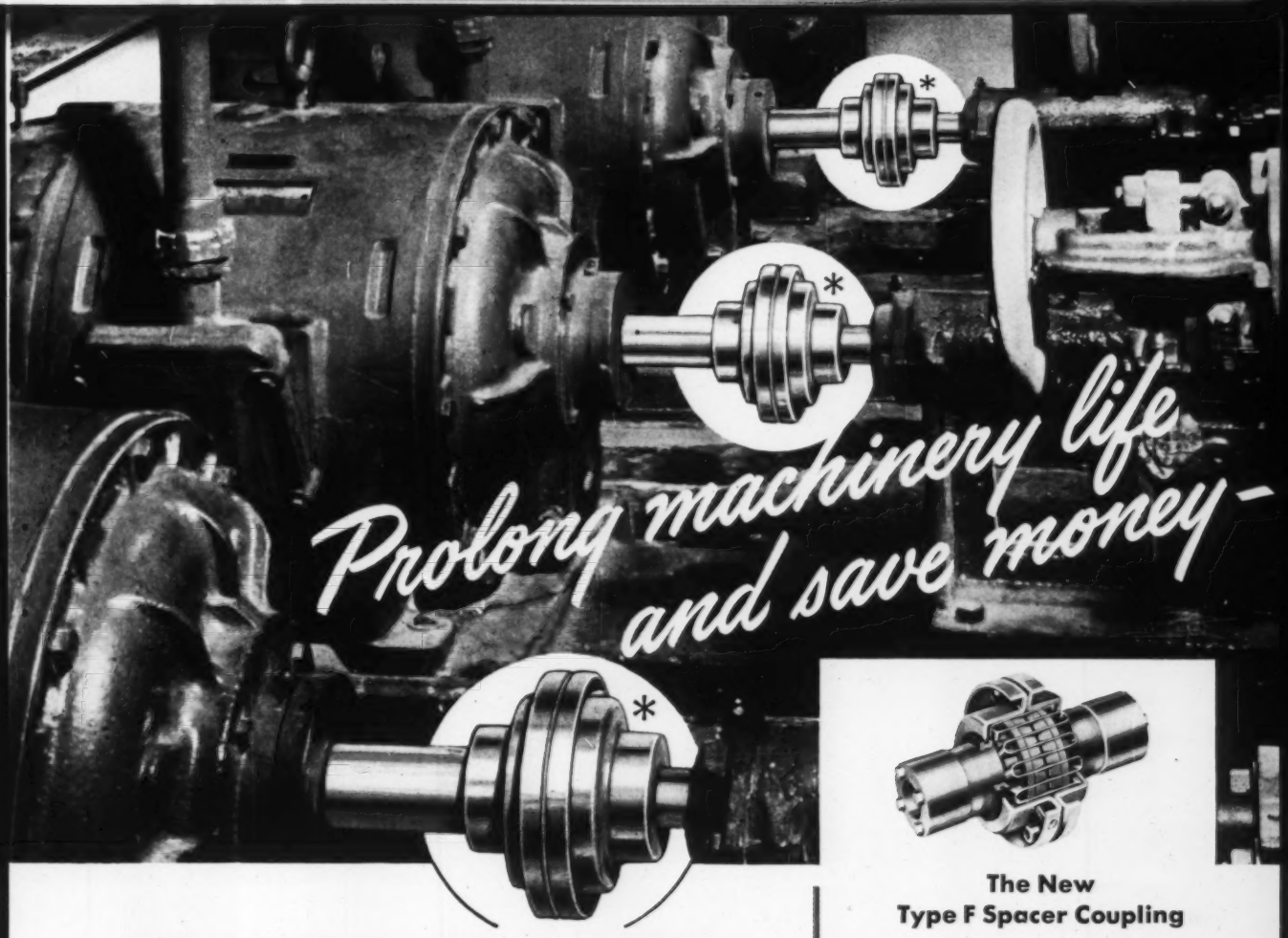
### SELECTROMATIC PANEL WITH "VARIABLE-GROUP" CONTROL

Note complete operating information and protection provided at top of panel. To start complete cleaning cycle, operator simply turns switch handle (he can immediately retract any blower during operation by turning handle in other direction); when programmed cleaning cycle is completed, shut-off is automatic. Each blower has an indicating light and a three-position switch: (1) automatic operation, (2) bypass, and (3) manual operation. Each group has a two- or a three-position switch: (1) automatic operation, (2) bypass, and (3) repeat operation (when desired). Group selection box at bottom permits any desired sequence of group operation by proper arrangement of plugs and jacks. Complete flexibility of cleaning control is provided.

Selectromatic panels are also available without "Variable-Group" features so that blower groups always clean (or are bypassed) in same sequence. Still another modification omits group control entirely.

## DIAMOND POWER SPECIALTY CORPORATION

**LANCASTER, OHIO** • *Diamond Specialty Limited* • *Windsor, Ontario*




# with FALK Steelflex Couplings

Ever since the first Falk Steelflex Coupling was designed and built, we have firmly held to these beliefs:

1. A coupling, to give fullest value, must do more than merely *connect* driving and driven machinery—it must *protect* the machinery and prolong its life.

2. A coupling, to be truly flexible, must overcome the effects of shock and vibration, as well as shaft misalignment.

Proof of the soundness of those beliefs is furnished by the record. More than one million Falk Steelflex Couplings have been used on every conceivable type of industrial application . . . giving trouble-free service, providing maximum protection to connected machinery.

* A single basic type—the famous Type F—fills 90% of all industrial application needs. It is versatile, efficient and economical. And—it is always available from factory, field or distributor stocks, in a wide range of sizes.

**Write to Department 247** for engineering bulletin, including selection and dimension tables.

**THE FALK CORPORATION, MILWAUKEE, WISCONSIN**

*MANUFACTURERS OF:*

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

**FALK**

**...a good name in industry**

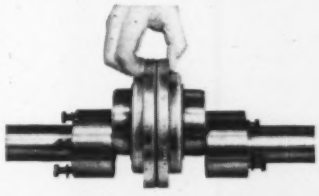


## The New Type F Spacer Coupling

Here is a Steelflex coupling specially designed to permit fast, easy installation and removal in horizontal and vertical applications where it is impracticable to move the connected units—or where a space-gap (up to 12 in.) is necessary.

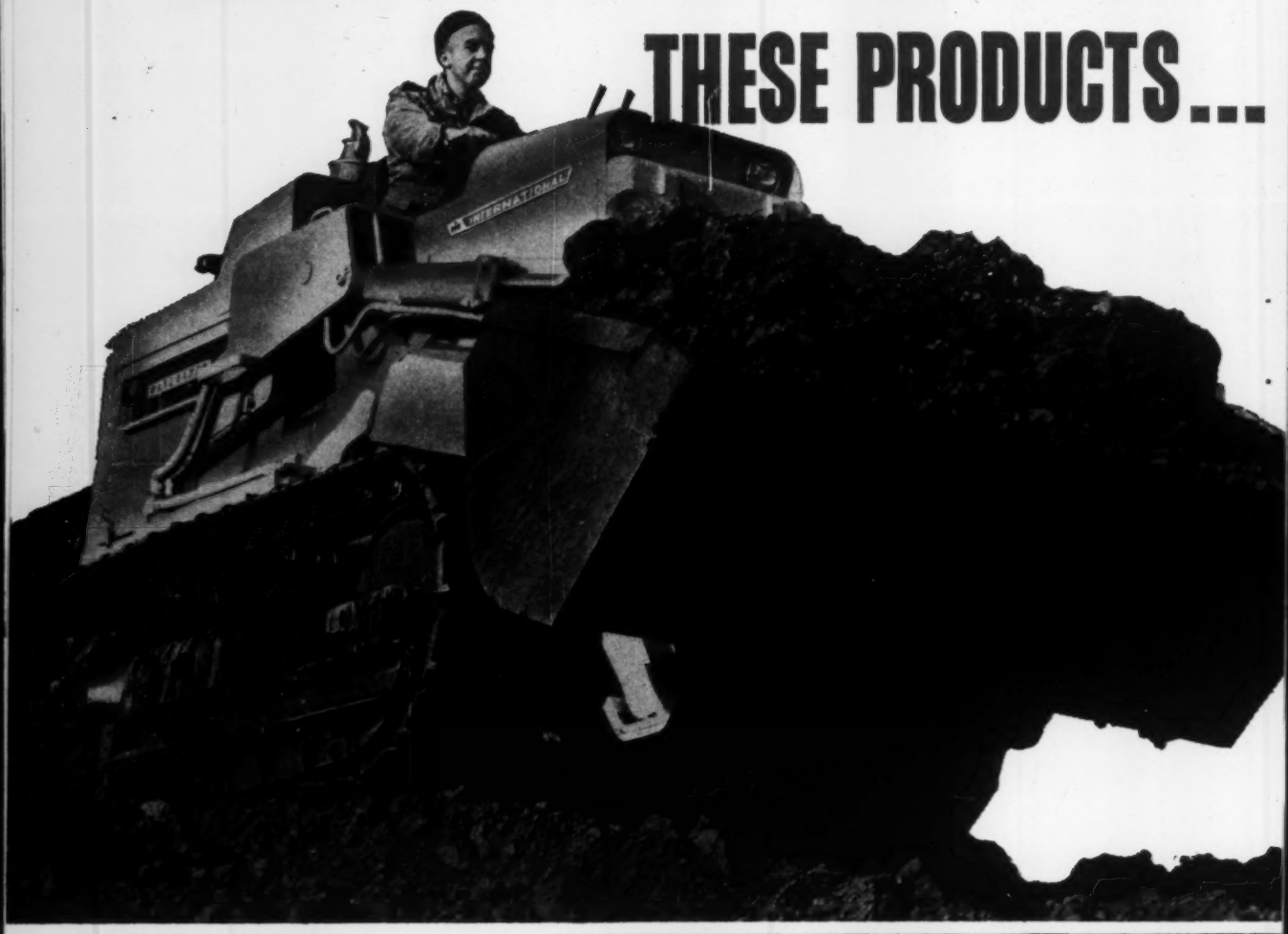
Like all Steelflex couplings, the Type F Spacer gives long, trouble-free service and maximum 3-way protection for connected machinery: it provides torsional resilience to reduce shock and vibration; it accommodates parallel or angular shaft misalignment; it allows free (or limited) end float.

An outstanding feature of the Steelflex Spacer is that it can be installed or removed in one piece (see photo below); no dismantling or servicing of the coupling is required. Pump assemblies can be disconnected and removed without disassembling the coupling, without exposing working parts.



The Steelflex Spacer coupling is prelubricated at the Factory and can be installed, or removed and reinstalled, without disturbing the lubricant—a highly desirable feature.

# HOW USS "T-1" STEEL IMPROVES THESE PRODUCTS....




**Pays Off In Payloader.** Speed is emphasized in International Harvester's new Model 12 Payloader. That means weight had to be cut. And USS "T-1" Steel helped cut weight of the rugged boom. This remarkably tough, strong steel is used at top and bottom sides where maximum stresses are imposed. The section depth of the USS "T-1" Steel parts is 12 inches. With other, less strong steels, section depths of 19 and 24 inches would have been required—much too large to fit the contour of the machine. USS "T-1" Steel cut size, weight . . . was cold bent, and welded to other parts of the machine by automatic submerged arc welding.

**Stops Brake Breakage.** Columbiana Cylinder Grinding Company, Columbiana, Ohio, does a lot of custom machining on industrial and mining equipment, including repair of brake and clutch bands for large earthmoving equipment. On the original equipment these bands are made of plain mild steel . . . often break under the tremendous stresses encountered. Columbiana replaces broken bands with new ones of USS "T-1" Steel—has yet to have a USS "T-1" Steel band break.

**More Strength, Less Weight.** This lift truck, in use at Baltimore Concrete Plant Corporation, and manufactured by Gerlinger Carrier Company, Dallas, Oregon, is the largest standard-line lift truck on pneumatic tires in the world. USS "T-1" Steel reduced the width and thickness of the forks on this truck. In addition, this extremely tough constructional alloy steel eliminated the need for shipping the forks 75 miles for heat treatment, which was required with the alloy steel previously used.

## HOW IT CAN HELP YOU

USS "T-1" Steel, with its high minimum yield strength of 90,000 psi and its minimum tensile strength of 105,000 psi, can help you design or build lighter-weight equipment that will last longer. Its unusual toughness can help you design or build equipment capable of taking severe impact and abuse at sub-zero temperatures. Its excellent weldability can help you cut the cost of fabricating highly stressed parts, and reduce repair and maintenance expense. Its good creep rupture strength can help you put more durability in equipment that operates at temperatures as high as 900 degrees F.

Somewhere in your operation, versatile USS "T-1" Steel can help you. Write, wire, or phone United States Steel, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

**USS "T" CONSTRUCTIONAL ALLOY STEEL**

See The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

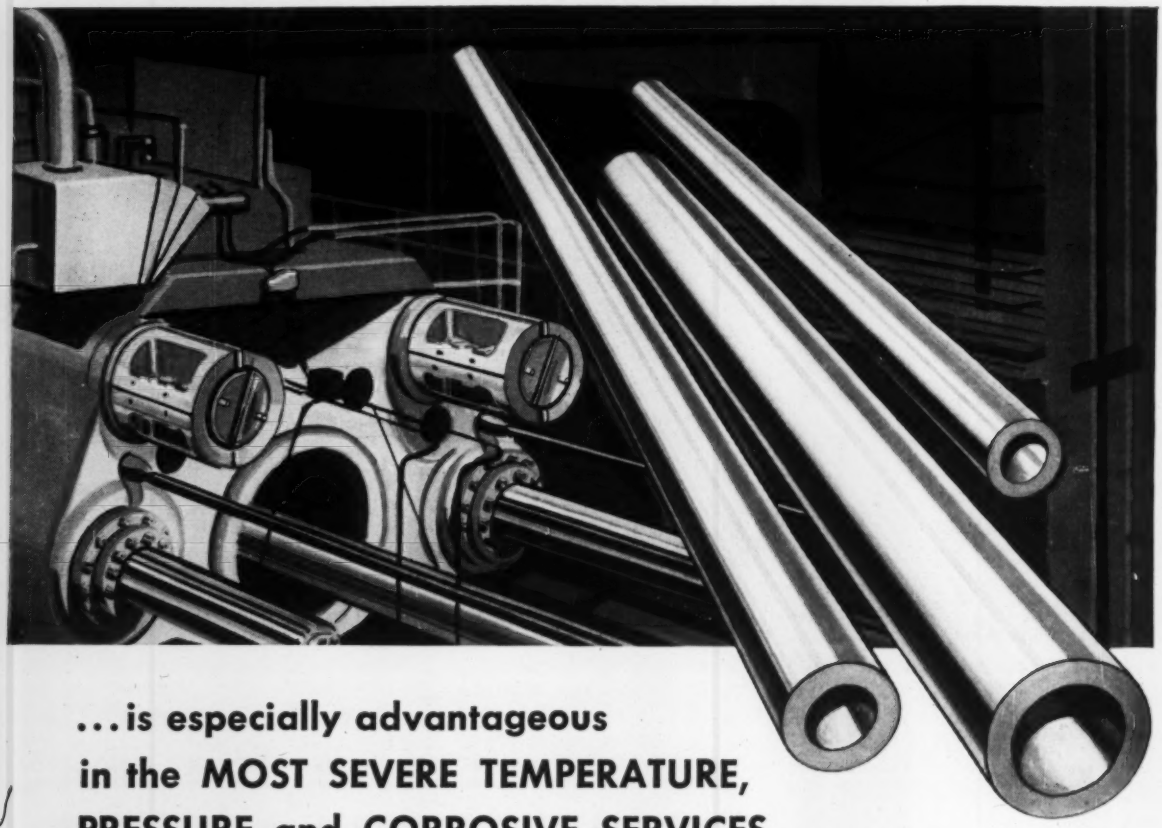
USS

UNITED STATES STEEL

# *HIGH INTEGRITY*

## EXTRUDED ALLOY STEEL PIPE

**available from 4″ to 22″O.D. in practically any wall thickness**



**...is especially advantageous in the MOST SEVERE TEMPERATURE, PRESSURE and CORROSIVE SERVICES**

A specially-built 12,000 ton extrusion press – capable of processing any of the stainless or other ferrous alloys – imparts vastly improved mechanical properties to new Curtiss-Wright ***HIGH INTEGRITY*** pipe. *High ductility with high strength* and *higher resistance to stress at high temperature* are automatically built into even the largest diameters and thickest-wall products. In the larger diameters, 10″ and above, the economics of ***HIGH INTEGRITY*** pipe are particularly attractive.

Major economies are regularly effected in fabrication and installation . . . using the longer units – up to 50 feet. Ultrasonic testing of all ***HIGH INTEGRITY*** pipe – combined with the more conventional test methods – assures uniform, dependable, specification quality of delivered product.

Curtiss-Wright's Metals Processing Division maintains qualified engineering personnel at all branch offices, available for design consultation and specification pricing.

**84 GRIDER STREET**

METALS PROCESSING DIVISION

**CURTISS-WRIGHT**

CORPORATION • BUFFALO, NEW YORK

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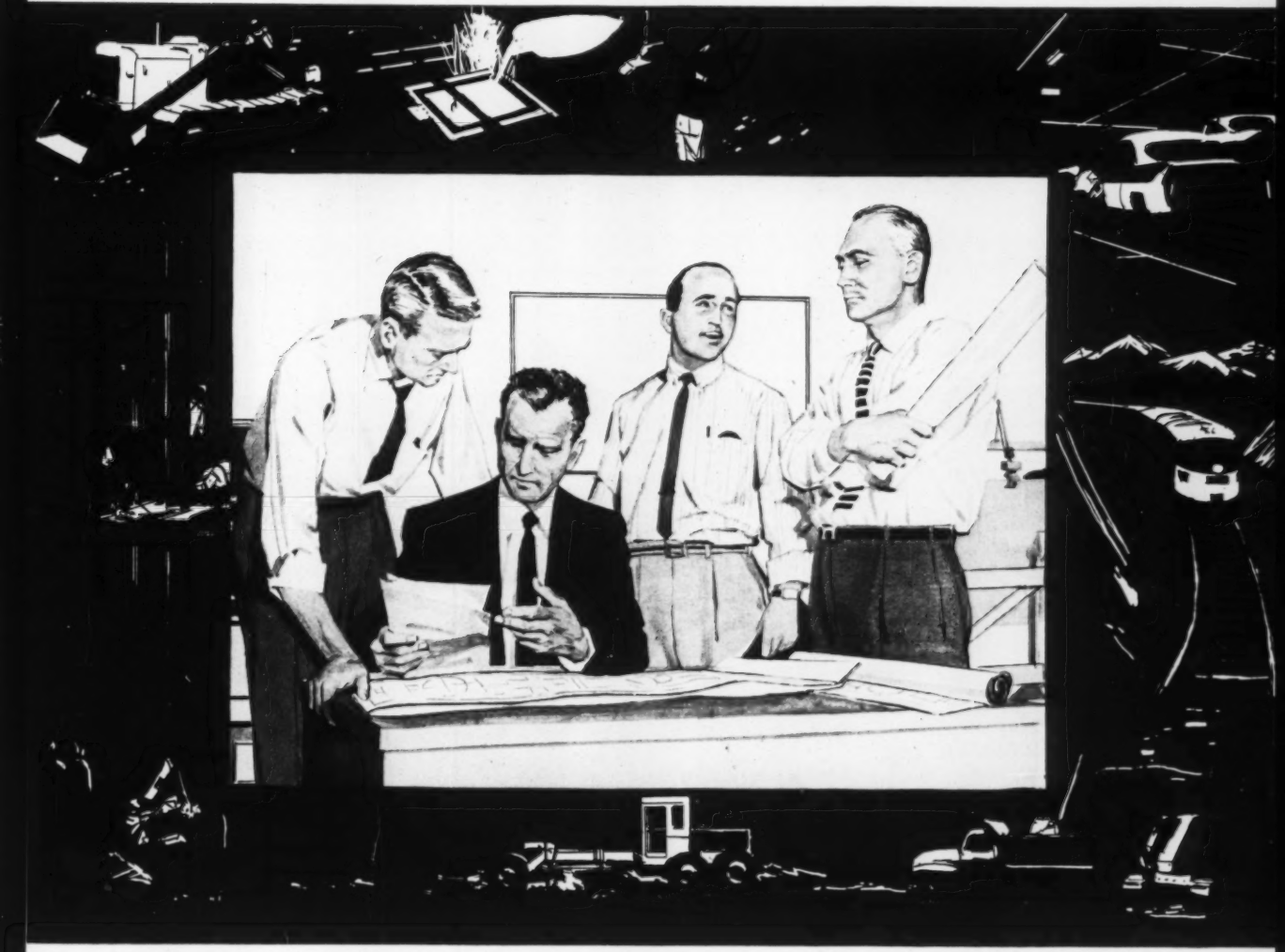
# *Production Boom Putting on Pressure for Greater Drafting Room Output?*



## *Now* IS THE TIME TO ACT *in Behalf of Your Company and Yourself!*

Chances are that your company, like most, is gearing up for greater-than-ever production. That means more and more pressure on your drafting department for engineering drawings and prints. You owe it to your company and yourself to equip your department, right now, to meet growing demands with greater output!

New, higher-production equipment and materials can help you do it! Never has there been a better opportunity to replace old, inadequate equipment with the efficient new products you've been wanting. With management's desire for greater production, you couldn't pick a better time to get approval for new equipment expenditures.

**BRUNING**

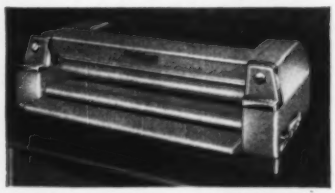
To discover for yourself how many ways you can boost drafting room output, yet save time and manpower, take a minute to look over the next three pages. You'll be glad you did!

# Look How Many Ways You Save Time and Money With

## Check the Places in Your Drafting Room Where Production Bottlenecks Can be Eliminated by Modern Bruning Products!

### (1) Modern Copyflex Machines Speed Reproduction, Cut Operating Costs

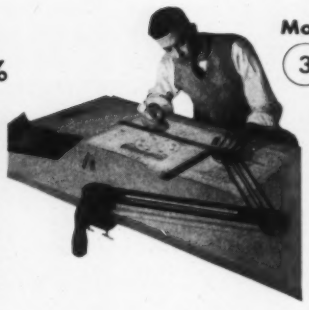
Five new and advanced machine models introduced in just the last year! They offer you all the benefits of diazo black-on-white reproduction, plus problem-free installation and operation. No fumes, no exhaust ducts. They bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. There's a Copyflex model to meet every need. New, better Copyflex sensitized materials work together with Copyflex machines to give you premium results.



**JUST OUT!** New Tabletop Model 300 with 30-inch printing width! Now the smallest engineering department can afford the advantages of "inside" reproduction with low-cost Model 300. The largest company can economically supplement its reproduction center with additional, strategically located Model 300s.

### (2) Modern Bruning Drafters Speed Drafting up to 30%

Over conventional equipment, Bruning drafters speed drafting up to 30% on most jobs . . . up to 40% on some structural drawings. Patented "Equipoise" gravity compensator, exclusive touch control indexing provide unrivalled simplicity, precision, and ease of operation. Full range of models including Counterbalanced and Track Drafters. Standard or Civil Engineer protractor heads.



### Modern Bruning Tracing Mediums (3) Speed Drawings, Enable Sharper Prints

These improved drawing mediums are unsurpassed for translucency, pencil-and-ink taking qualities, and permanence. You make drawings and tracings far easier and faster, get cleaner and sharper prints. Select from a complete variety.

# Can Boost Drafting Room Output, New, Modern Bruning Products!

## Why Let Old and Inadequate Equipment and Materials Stall Operations Now, When More and More Output Is Demanded of Your Department? Every Day You Delay Is Costing You Time and Money!

Here are the modern, higher-production products—some the newest on the market—that can help you boost drafting room output by replacing old and inadequate equipment and materials. A pioneer researcher in its field, Bruning still leads the way today with such developments as newly improved tracing papers and cloths that are setting a new standard in their field . . . newly improved sensitized materials that give you quality reproduction never before attainable . . . new, improved Copyflex machines that set a new high in quality, convenience, and economy of reproduction.

Researcher, manufacturer, and supplier . . . Bruning provides you a single, convenient, dependable source for everything you need in top-quality drafting room supplies and service. You simplify ordering and stocking, save time and money. Companion products, like Copyflex reproduction machines and Copyflex sensitized materials, are made to work together to give you premium results.

**(4) Modern Hamilton Drafting Tables Provide up to 50% More Use of Floor Space**

You can put six Hamilton Auto-Shift tables where you now have four boards with separate reference desks. The unique design of Auto-Shift increases the efficiency of draftsmen, reduces waste motion and fatigue. Bruning has a modern drafting table to suit every need and budget.

**(5) Modern Hamilton UnitSystem Files Save Time, Space; Permit Orderly Expansion**

You choose the individual filing units you need and combine them in an integrated and interlocking stack. You save time because drawings are easier to file and find. You make the most efficient use of space, expand your filing set-up in an orderly fashion.

### More Products from Bruning to Help You Step up Production, Save Time and Money!

**Modern Drafting Tools and Supplies Help Speed Draftsmen's Work**

Bruning's wide selection includes not only standard items, but many special time-saving aids such as dotting pens, proportional dividers, planimeters, and Wrico lettering sets.

**Modern Bruning Erasing Machines Save Hours of Manual Erasing**

Do a neater, safer erasing job. Save hours of finger-cramping manual erasing. Patented hollow shaft permits use of extra-long, seven-inch eraser, prevents "fly-outs." Quiet, cool, vibration-free.

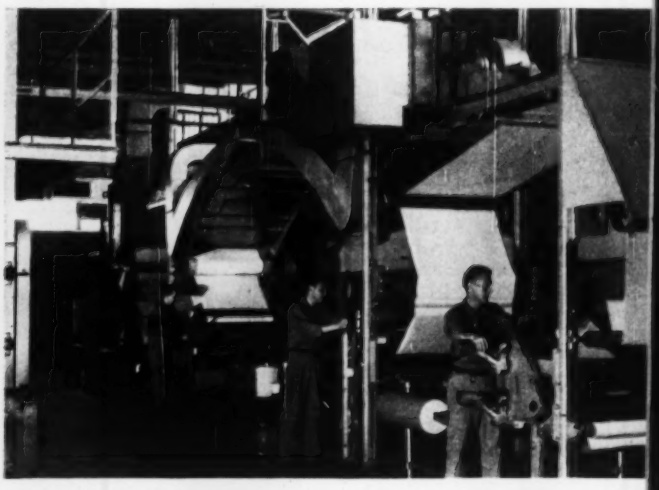
**BRUNING** *Gives You More to Help Boost Output*

# 3 More Reasons

## Why You Can Depend on Bruning to Help You Boost Drafting Room Output, Save Time and Money!

**New and Better Products**
**—from Bruning Research and Engineering**

In the past, it was Bruning Research and Engineering that introduced the first pencil tracing cloths, the first fume-free whiteprinters in America, the first band-type drafting machines. Today, by virtue of its modern laboratories and large engineering staffs, Bruning still leads the way in the development of new and better products. In just the past year, Bruning introduced five new, advanced reproduction machines . . . many newly improved tracing materials.



**Consistently High Quality**
**—from Bruning Manufacturing**

In its own modern paper converting plants at Teterboro, N. J., Chicago, Kansas City, Los Angeles, and Toronto, Ontario, Bruning controls quality all the way to bring you tracing mediums and sensitized materials of dependable, consistent high quality. The famous Copyflex reproduction machines are entirely Bruning manufactured to provide you the finest in reproduction performance.

**The Product and Help You Need When You Need Them—from Bruning Sales Service**

With the most comprehensive network of sales-service branches, distributors, and plants in its field, Bruning assures you of prompt, dependable service and supply. Your nearby Bruning branch is headquarters for a capable staff of Bruning sales-service specialists who are immediately available to you. Your nearby Bruning branch or distributor carries a full line of Bruning products and is staffed and equipped to give you fast, efficient supply. You suffer no costly delays for lack of supply or service.

America's Leading Supplier of
Engineering and Drafting Equipment

**BRUNING**

There you have it—the "big package" from Bruning to help you meet the demand for greater drafting room output! You get a complete line of modern, high quality products! You get better service. They work together to bring you better results at lower cost.

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# NEW ALCOA ABRASIVE ALUMINUM TREAD PLATE MEANS SAFE FOOTING!

## slip-proof under oil or water films on inclines up to 30°

Now you can eliminate lost man-hours from slip-slide accidents on oil- or water-covered walkways, ramps and ladders. New ALCOA® Abrasive Tread Plate is slip-proof! Made of a tough aluminum alloy, it has slip-proof aluminum oxide rolled right into its surface. That means safe, sure footing even when this new tread plate is covered with oil or water and inclined at angles up to 30°.

Like all aluminum products, new ALCOA Abrasive Tread Plate cannot rust . . . won't corrode in atmospheres normally corrosive to most metals. One-third the weight of steel, it's light and easy to handle. It's easy to fabricate and comes in standard sizes and thicknesses.

If slip-slide accidents are a problem in *your* plant, solve it once-and-for-all with ALCOA Abrasive Tread Plate. Use it for all your walkways, ramps and ladder treads! See your nearby ALCOA distributor or use the handy coupon for full details.

**THE ALCOA HOUR**
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

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**Mail this for new free book on Alcoa Abrasive Aluminum Tread Plate**

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Gentlemen:
Please send me your new 8-page booklet, *Alcoa Abrasive Tread Plate.*

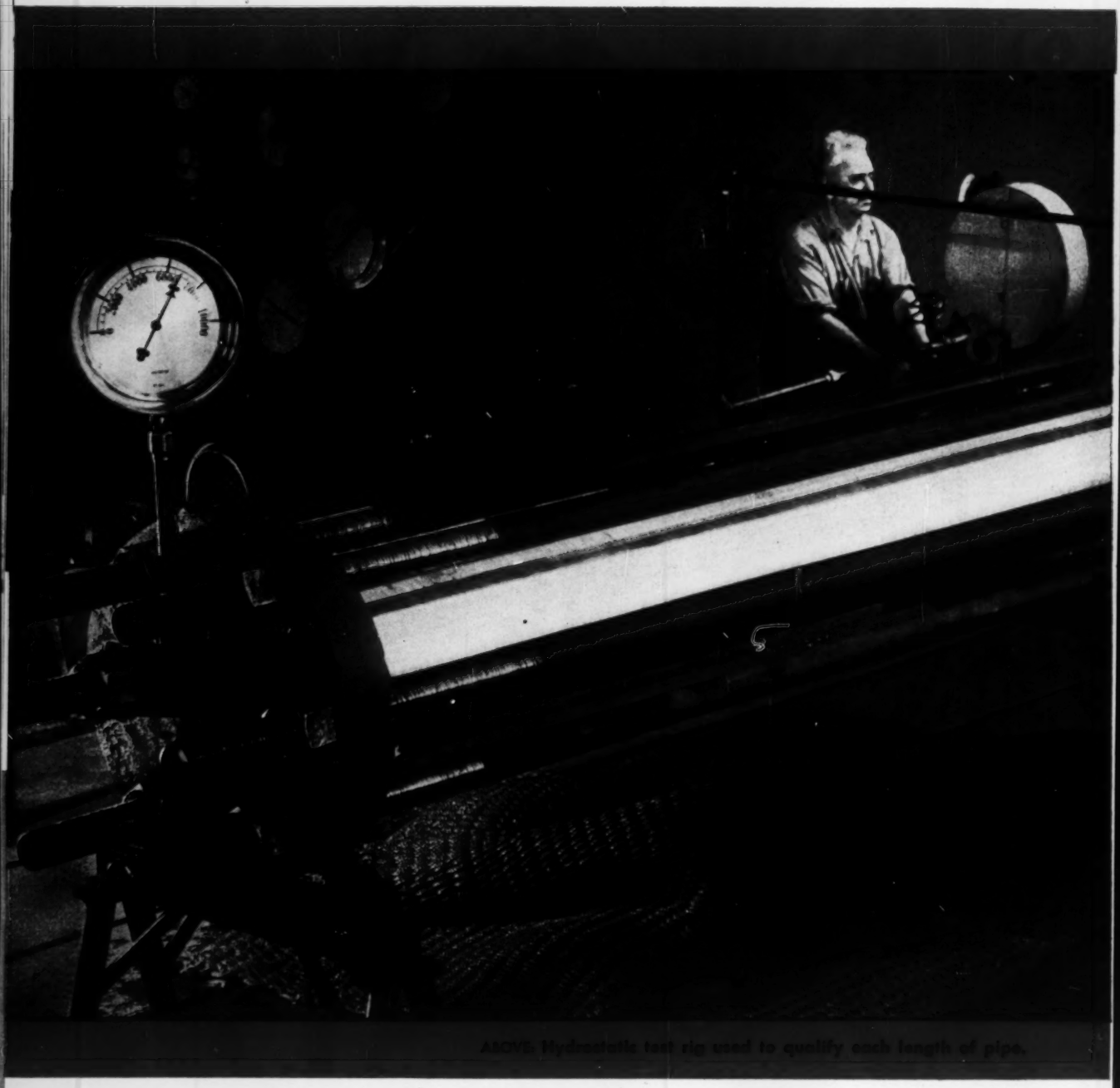
Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State _____

# STAINLESS STEEL CENTRIFUGALLY CAST MAY BE



ABOVE: Hydrostatic test rig used to qualify each length of pipe.

## UNITED STATES PIPE & FOUNDRY CO.

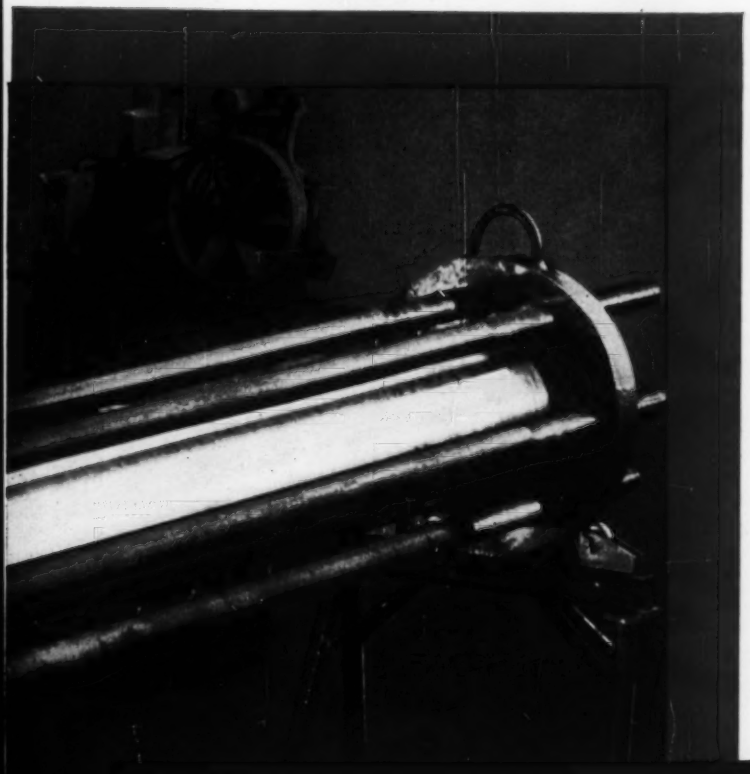
*Steel and Tubes Division*

STEEL AND TUBES DIVISION U S P

BURLINGTON, NEW JERSEY

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, COLUMBUS, DETROIT, PITTSBURGH, HARTFORD, BURLINGTON

# THE ANSWER TO YOUR PIPING PROBLEM



## Patented U.S.P. process meets rigid refinery specifications

The men who design today's petrochemical plants, refineries or Atomic power plants are confronted with piping problems involving temperatures, pressures and corrosive conditions which only a few years ago would have been called impractical, if not impossible.

U. S. Pipe's Steel & Tubes Division recently completed a piping requirement for 700 feet of Type 316 Extra Low Carbon, columbium-bearing stainless for a large petrochemical plant, which is typical of the job metal mold centrifugally cast pipe is doing today under a patented manufacturing process with rigid Quality Control.

U. S. Pipe is headquarters for metal mold centrifugally cast alloy and stainless steel pressure pipe over a wide range of special and standard analyses —in large or small quantities.

Write and outline your refining problems. We may be able to help.

**Note these exacting specifications on 316 Cb ELC Stainless Steel Pipe demanded by one of nation's leading oil companies:**

**MATERIAL REQUIREMENTS:** Pipe shall conform to ASTM Specification A-362-52T.

**CHEMICAL ANALYSIS:** Modified AISI Type 316 Cb (ELC), with *one percent* spread on chrome and nickel.

**FINISH:** Each pipe to be turned, bored and faced to surface finish of 125 micro inch or better. O.D. tolerance plus 1/16″ minus 0″; I.D. tolerance plus 0″ minus 1/32″.

**MECHANICAL TESTS:** Tensile Tests—2 tests required on each pipe after heat treatment; one at room temperature, one at 700° F.

**INSPECTION REQUIREMENTS**

1. Etching test on sections cut from each end of pipe.
2. Radiographic Inspection—Required complete circumferential coverage of at least an 8″ wide section at each end of each pipe in accordance with ASTM Specification E71-52.
3. Fluid Penetrant—Entire O.D. and I.D. surface each piece.

**HEAT TREATMENT:** Heat for 4 hours at 2100° F.—2150° F., water quench, follow by 5 hours at 1500° F.—1600° F. Cool in still air.

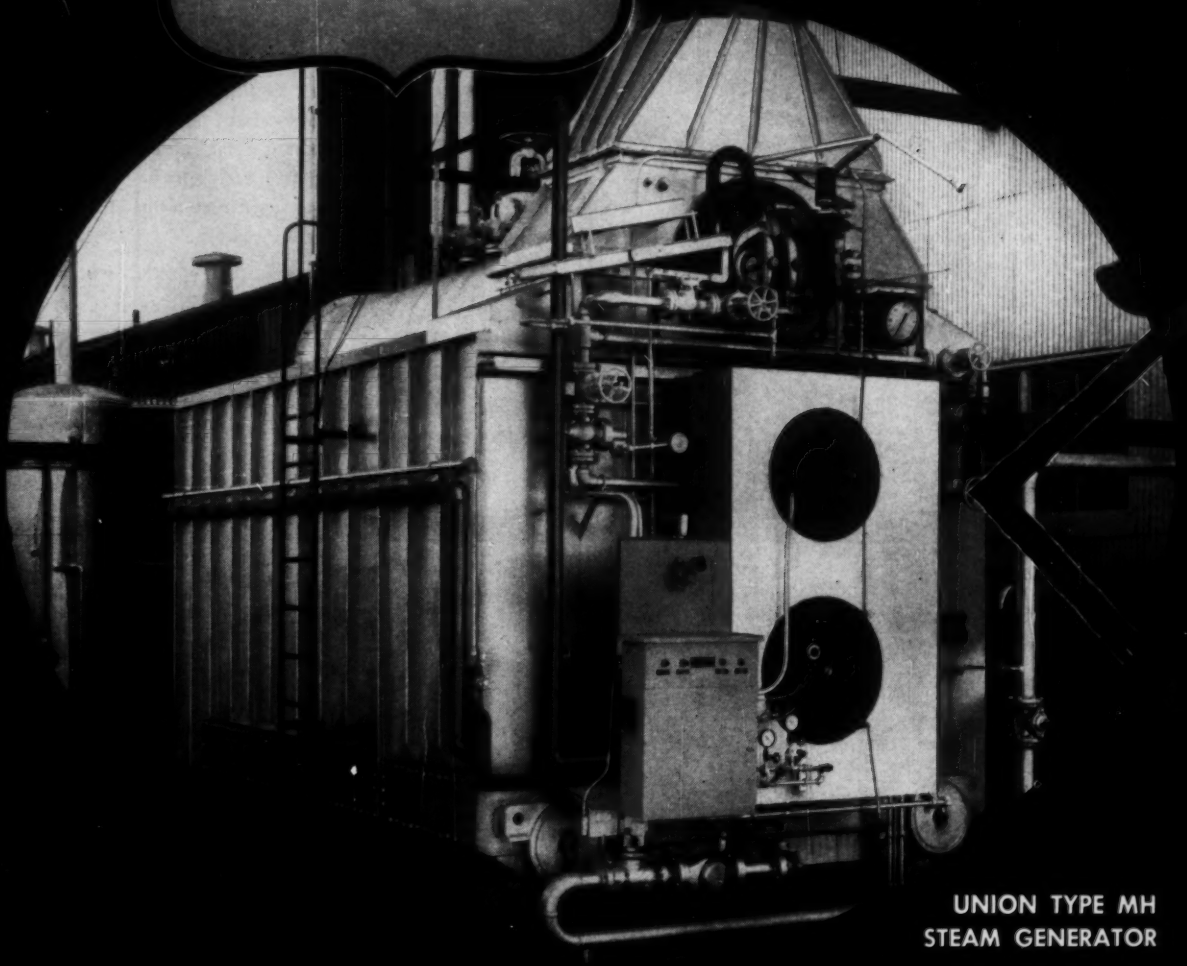
**HYDROSTATIC TEST:** Each length tested to stress of either 90% of the minimum cold yield strength or a maximum pressure of 6800 psi—whichever is lower.

**SIZE RANGE AND COMPOSITION FLEXIBILITY**

Outside Diameter—6″ to 50″
Wall Thickness—⅜″ and up
Length—Up to 16′
Types of Stainless—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.

# the PACKAGED BOILER

UNION



UNION TYPE MH
STEAM GENERATOR

***Compare!*** Make a feature-by-feature appraisal of the modern Union Type MH Steam Generator. Here's the packaged boiler most apt to be **right** for you.

That's because the compact, 3-drum MH has not only been patterned after Union's larger, 16-year successful, field erected Type H, but it can be equipped to fulfill multitudes of steam requirements. No other packaged unit is so adaptable in meeting individualized needs within the 10,000 to 40,000 lb hr range. No other boiler will do so much for **you.**

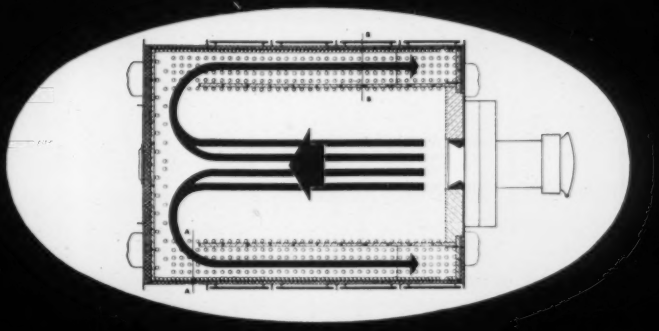
**SEE FOR YOURSELF!**

**FREE:** Illustrated, 16-pg Bulletin MH 354 will be mailed on request. Containing cut-away illustrations, installation photos, tube arrangement layouts and specs, it will give you the complete story. Write for your copy today.

**UNION IRON WORKS**

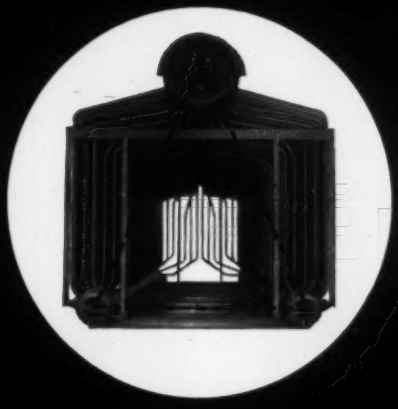
ERIE, PENNSYLVANIA

# that "HAS EVERYTHING"



### HIGH MASS GAS FLOW, HIGH HEAT TRANSFER

The straight-through gas flow over the divided tube banks requires furnace baffles only. Tube pattern provides high heat transfer and low exit temperatures without the higher draft losses of a staggered tube arrangement.

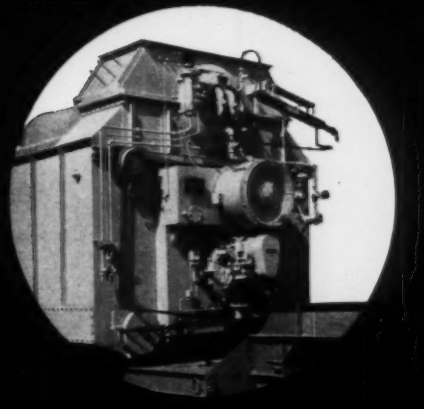


### BALANCED, 3-DRUM DESIGN

A bare tube view gives you at-a-glance proof of the basic soundness of the MH design. There are no long furnace floor tubes, water wall headers nor circulator connections to impede circulation. The MH can be brought on the line quickly and will readily handle fluctuating steam demands.

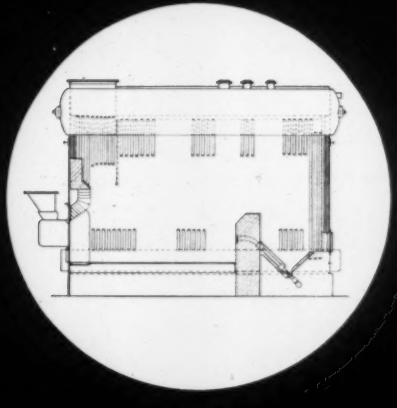
### DIVIDED TUBE BANK, TANGENT TUBE WALL CONSTRUCTION

Divided tube banks enclose a self-contained furnace and provide multiple tube rows between furnace and casing walls. This arrangement and the use of tangent tubes in outer rows bring about minimum radiation losses and low casing temperatures.



### MEETS PRESENT AND FUTURE FUEL NEEDS

The MH Steam Generator can be equipped for oil or gas firing or both . . . or for burning refuse or by-product fuel. It can be furnished with either fully automatic, semi-automatic or manual ignition and combustion control.



### READILY ADAPTABLE TO STOKER FIRING

The MH is so designed that it may easily be converted to stoker firing . . . without requiring any changes in pressure parts. Installation is simple. With the furnace floor removed, only minor alterations need be made to the draft equipment.

### OUTFITTED TO MEET YOUR SPECIAL REQUIREMENTS

Superheaters, of the pendant type, with or without control, can be installed to meet total temperature requirements. Heat recovery equipment is supplied when needed. High pressure units are also available for special applications.

# FACT: New floating roll-table drive solves space, shock, maintenance problems

Basic facts show how Westinghouse floating gearmotors bring greater efficiency and economy to roll-type conveyor operations:

**FACT 1: Space needs minimized by compact drive design**
Shaft suspension of drive and absence of separate coupling give maximum spacesaving and assure greater operating safety.

**FACT 2: Roll shocks cushioned by spring mounting**
Spring mechanism on anchor arm and "on-shaft" mounting enable this gearmotor to withstand shocks and stresses from roll eccentricity.

**FACT 3: Maintenance reduced by drive simplicity**
Absence of couplings, simple yet rugged gear arrangement and integral design of over-all unit all combine to cut maintenance needs to the minimum.

For more facts on this or any Westinghouse gearing equipment, call *The Man With The Facts*... he's the Westinghouse sales engineer at your nearest Westinghouse sales office! J-07343

A locking screw and clamping plate lock this compact gearmotor firmly to roll-table shaft. All power is transferred to roll shaft at low unit pressures.

***WATCH WESTINGHOUSE!***

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

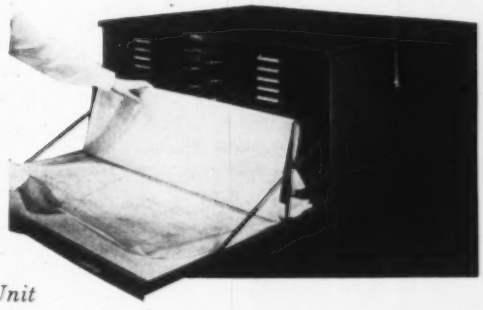
# You'll get more work done...

*Auto-Shift Table*

The man at the Auto-Shift produces more. Two finger-tip controls adjust board height and slope so easily that working position can be frequently changed—board can be instantly, effortlessly shifted to most convenient and comfortable position. Work is shifted to draftsman—draftsman never reaches for work.

# and handle it better...with

The tracing you want is *always on top* in a Hamilton Shallow-Drawer unit. An exclusive Hamilton *tracing lifter* supports all tracings filed above—permits any one tracing to be easily located, removed or refiled. When drawer is closed, same *tracing lifter* compresses all sheets—keeps them flat and wrinkle-free



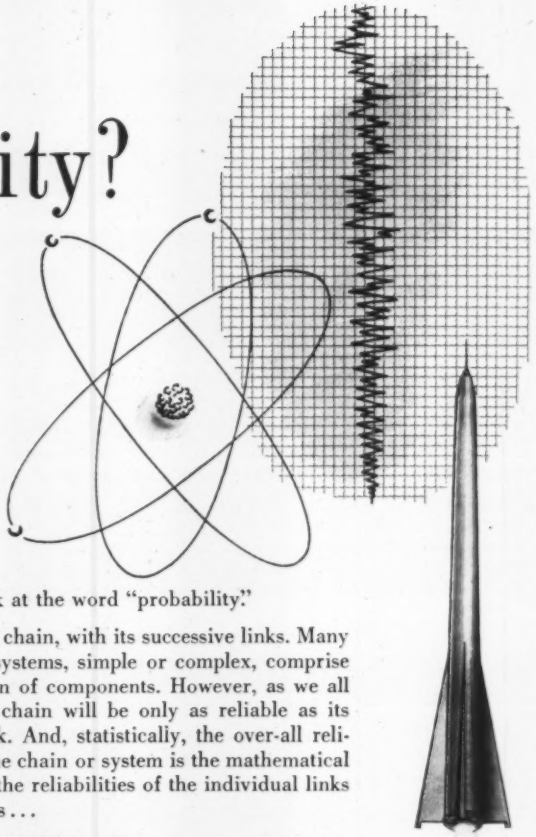
*Shallow-Drawer Unit*

# Hamilton Drafting Equipment

HAMILTON MANUFACTURING COMPANY • TWO RIVERS WISCONSIN

*FIRST OF A SERIES*

# What is reliability?



**Industry in the United States is becoming more and more complex... we're getting automated ... computers are computing... the missiles are flying... the digits are digitizing...**

**And the word "Reliability" takes a new and different meaning... what does it mean to you?**

It's time to stop and take a look! Ask three of your friends how they define "reliability." You'll be surprised at the different answers you receive. And when you quiz them further on how much reliability is needed in a particular product... how they would control the design and manufacture of that product to obtain the amount of reliability they want... you'll be even more surprised by the variety of the answers.

So... let's define reliability. Let's start off with a definition that is gaining the most acceptance in the technical field...

***The reliability of a particular component or system of components is the probability that it will do what it is supposed to do under operating conditions for a specified operating time.***

Looks simple enough!

But what hazards it presents! The first important challenge is that word "probability"... it takes you seriously into the field of data collection and statistical analysis. Then you check into the phrase "do what it is supposed to do"... someone must define these objectives. And, look at the "operating conditions"... pause briefly and reflect on the many different conditions under which products operate. And, finally, note the phrase "for a specified operating time"... does one normally, consciously, define reliability in terms of time?

These considerations pose problems for all of us... the manufacturers of components, those who assemble components into other products, systems personnel, designers, industrial engineers, production workers, purchasing agents, quality control... *and users!*

Let's look at the word "probability."

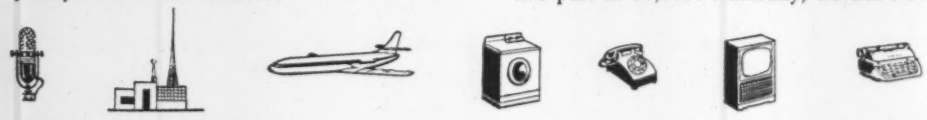
Picture a chain, with its successive links. Many of today's systems, simple or complex, comprise such a chain of components. However, as we all know, that chain will be only as reliable as its weakest link. And, statistically, the over-all reliability of the chain or system is the mathematical product of the reliabilities of the individual links expressed as...

***Over-all Reliability,*** $R_0 = r_1 \times r_2 \times r_3 \ldots r_n$

As an example, assume a product has a chain of 100 components in which each component has a reliability of 99 per cent... which assumes that only one out of a hundred units of each component will fail. These are relatively high standards established by past practices. But what happens? Multiplying .99 by itself one hundred times ($.99^{100}$), note that our chain of components will have a reliability of only 36.5 per cent! Two out of three of our chains would probably fail!

As another example, let's look at contacts in a multi-contact electric connector. If, for instance, we are to assemble connectors containing 25 similar contacts from a 1% defective contact population, we can expect 22% of the connector assemblies to contain one or more defective contacts! See how the multiplication of probabilities presents a major challenge to both designer and manufacturer?

But all is not lost! There is another side of the picture. With proper care, analysis, and control, our organization at Cannon has actually achieved, in special "missile quality" contacts, a known level of only 2.85 x $10^{-3}$% defective... or one defective part in 35,000! Naturally, we don't achieve



that with all our contacts . . . but we do try to design and manufacture the utmost in reliability required for specific applications.

However, to return to your problems and to go a step further in demonstrating "probability" of uncontrolled contacts . . . and the challenges it poses to you and to us . . . consider the case where we have three groups of contacts, each group with contacts of different sizes. Let us assume, also, that each group has different percentage defective populations and that the three groups are assembled in a 90-contact connector as follows:

50 No. 16 contacts with a population reliability of .59;
25 No. 12 contacts, reliability .60; and 15 No. 8 contacts, reliability .64.

Then . . .

$$R_c \text{ (90 contact connector)} = r_{\#16} \times r_{\#12} \times r_{\#8}$$

or,

$$R_c \text{ (90 contact connector)} = (.59)\ (.60)\ (.64) = .23$$

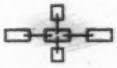
It is apparent from the above that connector contact populations must be maintained at extremely low values of percentage defective. This is of extremely vital importance if we are to produce connector assemblies which will perform satisfactorily in systems utilizing series circuitry, where the failure of one contact pair can cause failure of the entire system.

We have been talking only about *a contact* . . . just one of the many different materials and parts (such as contact pins, insulators, shells, and couplings) going into the more than 20,000 different connector and electrical items we manufacture. Think of the "product of reliabilities" rule in systems comprised of tens, hundreds, or thousands of electrical components connected by connectors such as ours. Regardless of whether they design, manufacture, sell, or use washing machines or guided missiles, everyone faces the same problem. That's why we're taking some of your valuable time to present the important subject of reliability here.

*

All of us, when we specify materials, parts or components must constantly keep in mind the (a) "probabilities," (b) what the part is supposed to do, (c) the operating conditions, and (d) the time it must operate satisfactorily. Let's see what we can do to increase reliability in relation to these four factors:

***(a) Probabilities.*** To increase the reliability of any component, and thereby the system as a whole, it is necessary to think in terms of statistical distribution of important physical properties. From field reports of failure and laboratory test results, we must first isolate those properties which most frequently cause trouble. It is then necessary to determine whether poor performance is due to lack of process control to keep the product within specified tolerance limits, whether the dollar sign has entered into the picture too far—cutting reliability down for the sake of a few cents here or there—or whether the design itself is inadequate for an end-use application. In any case, the use of the statistical approach to problem solution offers a positive method of obtaining known levels of reliability.



***(b) Definition of Function of Product.*** Each component and each system . . . both civilian and military . . . in each different field of endeavor, in each product produced, has different functions. None of us should "overbuild" . . . nor should we "under-build." We should look at our specifications closely.

***(c) Operating Conditions.*** Temperature and pressure, humidity, corrosive atmospheres, stray electric and magnetic fields, low and high frequency noise, shock and vibration . . . all must be considered plus conditions prior to product use.

***(d) Operating Time.*** This varies both for different products and different fields of application. Have you set reasonable lengths of operating time for your product or system, from the viewpoints of both usage and economics?

*

We at Cannon Electric are proud of our historical emphasis on quality and reliability. Since our inception in 1915 we have consistently adhered to a design philosophy embracing the highest quality and reliability in each Cannon Plug for the specific application for which it is to be used. *If we cannot design to that principle, we don't make it!* In manufacture, we are proud of our know-how in depth, proud of our fine quality control systems, proud of our personnel, and proud of our reliability control group. The "Cannon Credo" . . . part and parcel of the everyday life of each Cannon employee . . . is posted in all offices and all departments of all eight Cannon plants around the world. Three of its sections read as follows:

***To develop an organization of exceptional people possessed of respect for the dignity of the individual and imbued with the spirit of the team.***

***To provide a facility with which we can produce to our utmost in an efficient and pleasant environment.***

***To develop and produce products of such quality, and render such service, that we may always be proud of our efforts.***

*

Whenever *you* have an electric connector reliability problem . . . in design, engineering, production or prototype phases . . . we would welcome the opportunity of discussing it with you.

*Cordially,*

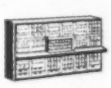
Robert J. Cannon *President*

CANNON ELECTRIC COMPANY
3208 Humboldt St., Los Angeles 31, California

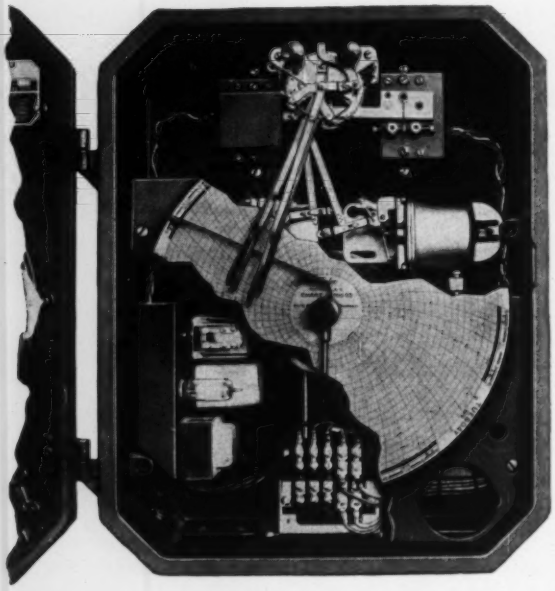
Please Refer to Dept. 417

**CANNON PLUGS**

*Eight plants around the seven seas!*



# NEW ELECTRONIC CONTACT CONTROLLER BY *Taylor*



## FEATURES

- Changing Resistor-Capacitor Can gives Single Point or Differential Control. Control point easily adjusted by set pointer.
- Fully adjustable, self-locking differential between high and low contacts. Safe contact voltage—never over 6 volts. Current in micro-amps.
- Self-wiping control contacts made of non-corrosive Monel. All other parts are hermetically sealed against corrosion.
- Electronic tube, Relay and R-C Can are plug-in units. Load Contacts on Relay are Single-pole double-throw.
- Attachments can be fitted to present 100 Series Taylor Instruments with no drilling.
- Internal wires and external connections numbered for easy servicing. Signal lights and vibration damping available.

HERE'S rugged, positive contact action for control mechanisms of the two-position action type—the "on-offs", "open-shuts" and "high-lows". This new Taylor Electronic Contact Controller embodies a completely new concept in contact mechanisms—it's designed for:

**1.** Accurate and dependable operation of electrical circuits.

**2.** On-off applications with small process lags, slow reaction rates, and small and infrequent load changes.

**3.** Use on nearly all types of measuring systems—temperature, pressure, liquid level, flow, humidity, speed, etc.

**4.** Indicating, recording and/or controlling purposes. An extremely versatile instrument, the new Taylor Electronic Contact Controller can be used in many different places where pneumatic facilities aren't advisable or available. It's made also for use as a supplement to pneumatic control.

These standard forms emphasize the flexibility of the instrument: Two-Position Single Point Action (On-Off), Two Position Differential-Gap Action (On-Off with adjustable differential gap or neutral zone), and Three-Position Differential Gap Action (High-Medium-Low, differential adjustable).

For full details ask your Taylor Field Engineer or write for **Bulletin 98265.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

*Taylor Instruments*
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

## How the LINK-BELT Roto-Louvre dryer

# guards your product quality and cost control

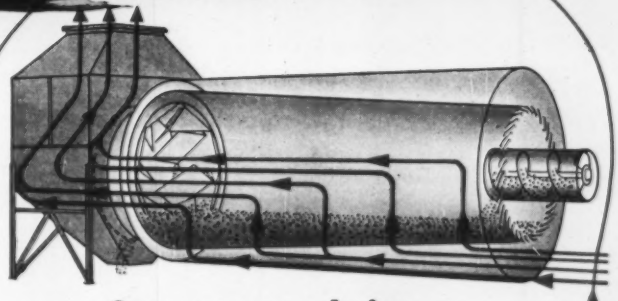
Roto-Louvre, shown in magnesium sulphate production, permits shorter retention time for material in drum . . . needs only half the floor space required by other designs.

*Provides gentle pre-drying, drying or cooling with laboratory accuracy*

THE dangers of overheating or degradation of your product make the drying cycle a key element of your quality and cost control system. Duplicate the pre-forming of your laboratory operation with a Link-Belt Roto-Louvre dryer.

This compact, highly effective machine introduces dry, heated air through ever-changing channels reaching the entire surface of every particle. Stratification and segregation—resulting in an irregular, overdried or underdried product—are prevented.

For a complete report on Roto-Louvre's remarkable efficiency, send for Book 2511. Or, if you prefer to send us a sample of your material, we can work out drying, cooling or roasting procedures you can duplicate in your own plant . . . using the right dryer from the broad Link-Belt line.



**Common-sense design assures effective heat transfer**

Roto-Louvre has largest volume of air penetrating thin bed of material near feed end, where greatest evaporation must take place. As material moves forward and bed becomes thicker, smaller air passages reduce volume of air passing through bed, preventing overheating. Precise control of input air temperature, exhaust and conditions of material travel assures maximum heat transfer per cubic foot of air.

LINK-BELT COMPANY
Prudential Plaza, Chicago 1, Ill.

Please send me 20-page Roto-Louvre Book 2511.

Name .....

Firm .....

Address .....

City..... Zn.... State.....

LINK-BELT

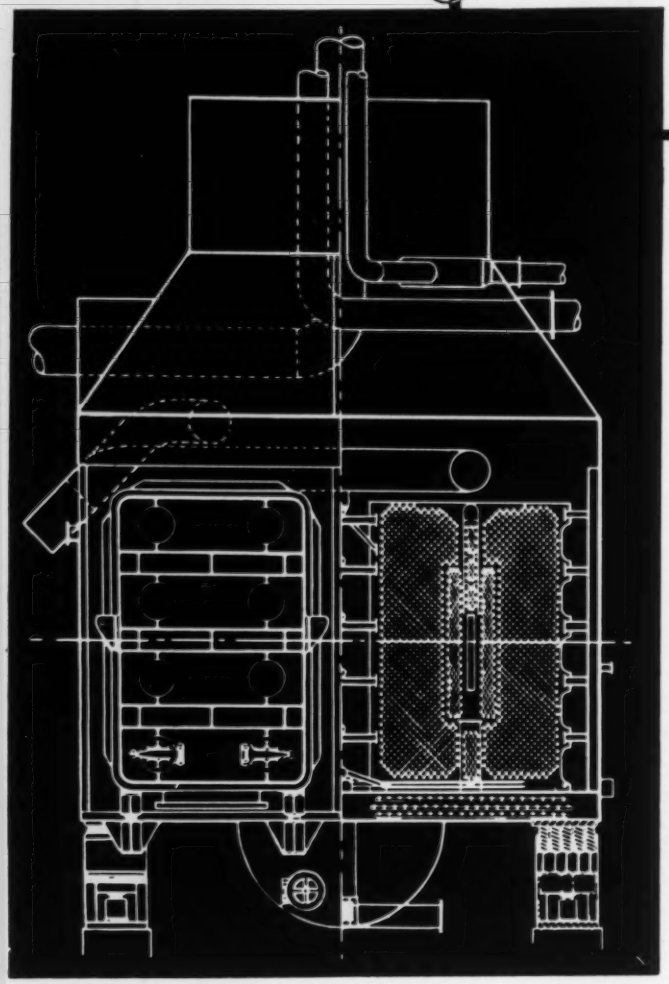
DRYERS • COOLERS • ROASTERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World 14,233

# DUAL BANK Condensers

*by C. H. Wheeler*

**For Your Electric Generating Plants of Tomorrow**



- Specifically designed for larger, more efficient electric generating stations.
- Adaptable to your station layout.
- Designed to minimize field erection problems.
- Additional steam lanes shorten path and resistance to steam travel.
- Lower pressure drop and higher vacuum.
- "Zero" condensate temperature depression.
- DEAERATION . . . 0.01 cc per liter is attainable.
- Purity of condensate.

*At C. H. Wheeler the most modern engineering techniques are at your service. Let our engineers help you. Contact your local representative or*

**C. H. WHEELER MANUFACTURING CO., 19th & LEHIGH, PHILADELPHIA 32, PA.**

Manufacturers also of Vacuum Equipment • Pumps for Circulating Water, Condensate, Water Supply and Drainage
Marine Auxiliary Machinery • Special Products for Atomic Service

WE 607

*C.H. Wheeler* OF PHILADELPHIA

SIGHTS of rockets swooshing heavenward become more and more familiar as we thumb through today's industrial publications. The recalcitrant rocket shown on this page indicates that things *can* go wrong in research, and we don't claim that the absence of a Sanborn oscillographic recording system somewhere along the line was the reason for this disappointing trajectory.

What we do wish to say is that Sanborn equipment is playing an increasingly vital part in rocket development. Used in the laboratory to record flight behavior simulated by analog computers, and in plotting rooms at testing bases to tape down telemetered data, Sanborn "150's" are helping rockets to get and stay where they belong.

You can see Sanborn systems in many other places, too. Oil fields, electronic component production lines, machine tool plants, hydraulic testing laboratories, numerous aircraft manufacturers, computing facilities . . . are putting single to 8-channel Sanborn systems to work. (Most are housed in vertical mobile cabinets, while those in the "field" are often divided into portable packages for each instrument.) All of them give their users inkless, permanent recordings in true rectangular coordinates, one percent linearity, as many as nine chart speeds, and the efficiency (and economy) inherent in Sanborn unitized design. A dozen different plug-in preamps further extend their value, by making changeover to new recording inputs a quick and easy procedure.

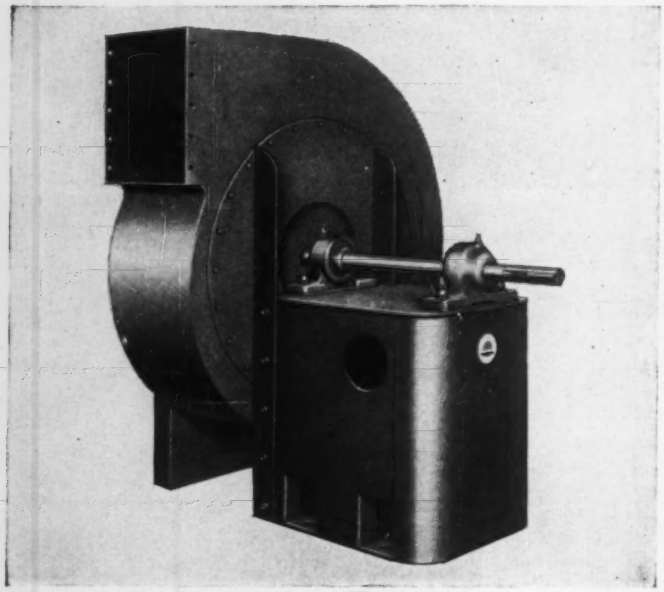
**SANBORN COMPANY**
CAMBRIDGE 39, MASSACHUSETTS

8-, 6-CHANNEL 4-CHANNEL 2-CHANNEL 1-CHANNEL 2-, 4-, 6-, 8-CHANNEL ANALOG COMPUTER SYSTEMS

**Which way rockets are going may not be a primary concern of yours. But if recording problems are, you're apt to find some interesting and useful answers in Sanborn's 16 page "150 System" catalog. Write to us for a copy.**

## NEW FEATURES! HIGHER EFFICIENCIES! NEW "3-IN-1" DESIGN!

# AMERICAN BLOWER SERIES 106 INDUSTRIAL FAN



Series 106 Industrial Fan

Certified ratings! Pressures to 18" w.g.! Volumes to 125,000 cfm! Heavy construction! Choice of 3 special-duty wheels! You get all these features, and many more in American Blower's new Series 106 Industrial Fans.

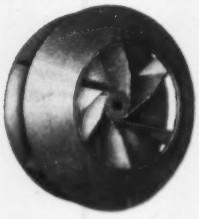
Available in 16 sizes, each with a high efficiency rating. Series 106 fans offer a wide range of optional accessories and construction features to meet standard or special specifications – *or* you can buy it in 7 sizes as an efficient, heavy-duty "packaged" industrial fan, complete with motor, V-belt drive and weathertight running-gear enclosure.

Get complete data from your nearest American Blower Branch Office, or write for Bulletin 5306-H.

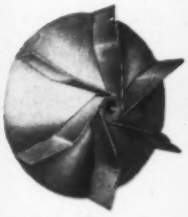
CERTIFIED RATINGS
AUTHORIZED BY NAFM
Certified Ratings
CFM

## Choose the wheel to fit the duty

**Air Handling** – for efficient handling of air, fumes, or gases – either clean, or containing light concentrations of dust or materials.



**Material Handling** – efficiently handles air or gases containing granular material – dust grain, exhaust from buffing or grinding wheels.



**Long Shavings** – specially designed for conveying or handling air or gases containing long stringy material – wood shavings, fibers, alfalfa.

## American Blower products serve industry

- Air Conditioning, Heating, Ventilating Equipment
- Mechanical Draft Equipment
- Industrial Fans and Blowers
- Centrifugal Compressors
- Gyrol Fluid Drives
- Dust Collectors
- Refrigerating Machines

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN-Standard

**AMERICAN** AMERICAN BLOWER PRODUCTS **BLOWER**

# Wrought Iron Pipe's built-in protection ... always "on guard" against corrosion

Wrought iron pipe's "armed guard" against corrosion is a concentration of thousands of glass-like iron silicate fibers distributed throughout the metal.

These iron silicate fibers are relatively immune to corrosion . . . so any attacks by corrosion are evenly dispersed over the entire surface of the metal. As a result of this built-in protection, deep pitting and penetration are repelled . . . costly premature repairs and maintenance are eliminated.

Our booklet, "The ABC's of Wrought Iron" tells more of this story. You'll find it profitable reading. Write for your copy today.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Division Offices in Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. International Division: New York, N. Y.

*Available in Canada and throughout the world.*

BYERS *Wrought Iron Tubular and Hot Rolled Products*

ALSO ELECTRIC FURNACE QUALITY STEEL PRODUCTS

## Typical Mechanical Properties of Ni-Vee Bronzes

| TYPE | A (lead free) | | | B (1% lead | | C (5% lead) | | D (10% lead) | | E (20% lead) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | As Cast | Tempered | Heat-Treated | As Cast | Tempered | As Cast | Tempered | As Cast | Tempered | As Cast | Tempered |
| Tensile Strength (thousand psi).... | 50 | 65 | 85 | 45 | 60 | 40 | 50 | 35 | 40 | 25 | 30 |
| Yield Strength (thousand psi)..... | 22 | 40 | 55 | 20 | 30 | 20 | 30 | 20 | 25 | 18 | 22 |
| Elongation, % in 2".....| 40 | 10 | 10 | 30 | 8 | 15 | 5 | 10 | 2 | 5 | 2 |
| Brinell Hardness..... | 85 | 130 | 180 | 80 | 120 | 80 | 130 | 80 | 110 | 70 | 80 |

# Specifying is simple and systematic with 5 versatile Ni-Vee Bronzes

Now . . . designers and engineers can readily select a suitable bronze for any specific need . . . from only five Ni-Vee* bronzes.

*"As Cast,"* these five Ni-Vee bronzes provide mechanical properties that surpass those of comparable G bronze, red brasses and leaded bearing bronzes. What's more, their superior properties can be still further elevated by simple heat-treatments.

*Basically, each Ni-Vee bronze contains 5% nickel and 5% tin,* from 0 up to 20% of lead. Tensile strength ranges from 25 to 85 thousand psi, and hardness from 70 to 180 Brinell.

### Advantages

*Just five of these Ni-Vee bronzes make it possible to standardize metal inventories, melting practices and shop operation . . . as well as specification . . . to meet many industrial uses for copper-base castings.*

Each Ni-Vee bronze contains an optimum nickel content to raise levels of strength, hardness and toughness. In addition, this nickel content provides a high degree of corrosion resistance in the Ni-Vee bronzes. Negligible zinc content makes it free from dezincification. This spells resistance to stress-corrosion attack.

### A versatile family

Copper-base alloys are ordinarily used for the three types of castings listed below. For each of these applications a Ni-Vee bronze provides particular advantages:

(1) **Constructional** castings – high strength
(2) **Pressure** castings – fine grain
(3) **Bearing** castings – resistance to wear and seizure

*The simple family of five Ni-Vee bronzes actually replaces the confusing variety of miscellaneous bronzes.* As a result, engineers and designers can now specify simply and systematically . . . specify Ni-Vee bronzes wherever possible. Parts cast in Ni-Vee bronze already serve *electrical, power, steel, petroleum, chemical, automotive, aircraft, railroad and other industries.*

### Engineering data for you

*Learn how the Ni-Vee bronzes can simplify your specification work,* improve product performance. Send for a copy of *"Engineering Properties and Applications of Ni-Vee Bronzes."* It contains useful information like that given in the table above: tables of composition, charts on deformation, friction, fatigue, elevated temperature service, electrical resistivity, wear and other engineering data. *Write for it now.*

*Registered trademark

INCO TRADE MARK

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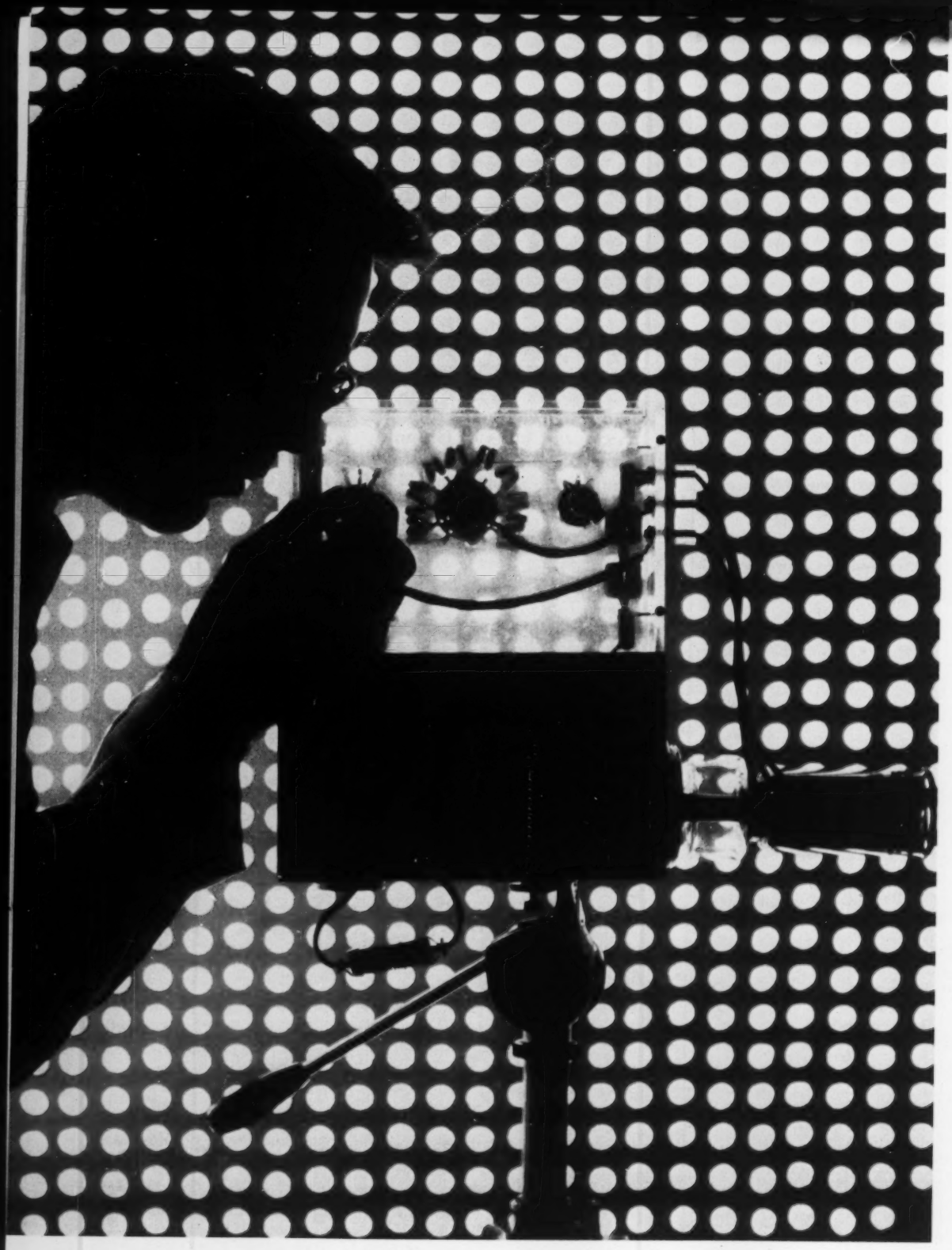

## New Television Camera Pickup Tube Principle . . .

. . . was disclosed during the dedication ceremonies on September 13 of the Research Laboratories of Westinghouse Electric Corporation near Pittsburgh, Pa. A test-pattern background silhouettes the tube. It is termed "Ebicon" from the initials of the phrase "electron bombardment induced conductivity" which is the phenomenon basic to its operation. The tube promises to be 100 times more sensitive than the standard tube used in television cameras. For further details on the Research Laboratories see page 1038 in this issue.

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George A. Stetson, *Editor Emeritus*
J. J. Jaklitsch, Jr., *Acting Editor*

# MECHANICAL ENGINEERING

## ASME Student Member Program

In order to give greater recognition to the Student Member in ASME activities, the Council, in June, 1956, adopted a new Student Member Program. The new program, which is being implemented this fall, is also designed to bring the students into more active membership in the Society and should go a long way toward instilling in student engineers a professional attitude and pride in belonging to the engineering profession.

Besides the procedures to improve Student Member contact with the Society, the program also provides increased services, including 12 issues of Mechanical Engineering per year (instead of eight as at present), a book of five coupons that may be exchanged for five technical papers presented at ASME Meetings, and a Student Member Pin (when elected Student Member). In addition Student Members will now share in activities and privileges of ASME membership but will pay only $5 per year with no initiation fee. The designation "Student Branch" is to be changed to "Section" and be identified by the name of the college at which the Section is located.

Other important changes and innovations follow:

Yearly enrollment will be discontinued. A qualified engineering student will now apply for membership in ASME, first as a Student Member, then, upon successful completion of requirements for an engineering degree, as an Associate Member.

Each new Student Member will receive a membership card and an invitation to attend Section and National Meetings of the Society.

Upon receipt from Headquarters of names and addresses of Student Members at Student Sections located within the geographical Section, the Section chairman will welcome them as ASME members and invite each Student Member to attend Section meetings.

With the co-operation and support of the Old Guard and the Faculty Advisers, the National Junior Committee will arrange panels of Old Guard and Associate Members (formerly Junior Members) to discuss subjects of interest to students.

Old Guard Members will serve, when available, as Student Councilors and attend Student Section meetings.

The Old Guard prize contest is to be continued.

At the beginning of the senior year, each Student Member will receive, with the compliments of the Old Guard, a copy of "The Unwritten Laws of Engineering."

Prior to graduation each Faculty Adviser will continue to recommend to Headquarters, with two additional references, those Student Member graduates eligible for the Associate Member grade. (The application for transfer has been discontinued.)

ASME staff will send a letter from the ASME President to each of the Student Member graduates with a membership card, 10 free coupons, dues statement, and under separate cover with compliments of the Old Guard, the ECPD "Professional Guide for Junior Engineers."

What prompted ASME to look into its Student Member Program? It was found that only 40 per cent of Student Member graduates transferred and paid dues as Associate Members. Further studies indicated that of the 40 per cent who did transfer to the Associate Member grade only 40 per cent, or 16 per cent of the graduates, remained in the Society after five years. It was evident, therefore, that the Student Members were not given sufficient incentive and that much additional work must be done by both the Faculty Advisers and ASME Sections.

This was clearly pointed up in a survey to determine what steps should be taken to improve the situation. The survey indicated that procedures for enrolling and transferring must be simplified, that Faculty and Members must take greater personal interest in the Student Member and the Associate Member if they are to retain their membership, and that ASME must provide services similar to those provided by other societies.

ASME has taken these steps and many more in its new Student Member Program. The machinery is now in motion and with the co-operative efforts of Faculty Advisers, Members, Sections, students, and ASME staff, it is to be hoped that the Program will be successful.

And to be successful, each engineering student must take pride in belonging to the engineering profession; he should be aware of his obligation to the profession and the need to contribute to its development by active participation in a professional society; he must have an understanding of the importance of continuing his professional development and education utilizing the means provided by ASME; he should prepare to become a registered professional engineer; and he must have an appreciation of the position of the engineer in our social and economic system through participation in civic affairs.

The ASME Student Member Program is designed to develop these traits in the engineering student; it is up to the student to take full advantage of the program and thereby reap the benefits, both now and in the future, of belonging to a professional society.

# How to Analyze the Cost of Machine Tools . . .

## . . . From the Swivel Chair

**Based on experience in retooling Norwegian motor plants, an equation incorporating machine-tool cost factors was developed and reduced to the form of a nomographic chart**

**By Realf Ottesen,** Affil. Mem. ASME

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Some years ago the author was faced with the problem of setting up general rules for the retooling program of many Norwegian motor-manufacturing plants. To avoid subjective arguments and to place general limits on the factors involved in deciding whether or not a new tool should be procured, and also to select the proper replacement tool, the author found it wise to treat the whole subject in a mathematical way. This proved especially useful in those cases where many varied production methods and machines are employed to complete the desired product. Furthermore, mathematical terms enjoy an ever-increasing popularity in these days when we are getting accustomed to employing elaborate computers on a wide scale. The analysis led finally to a simultaneous equation which for the sake of reproducibility was transformed into a nomographic chart with the aid of which the individual figures could easily be gathered and put together. The term "from the swivel chair" refers to the fact that this chart can be handled from the desk, and so allows the manager to select a suitable future tool, and also lets him survey his whole setup as to the plant's cost level and efficiency.

### Basic Idea

The idea behind this scheme is based on the following assumption:

In any factory the production force is the tool which machines the assumed product plus the laborer who spends his hours at the tool to bring it into the desired shape. Here we have two sources of cost, such as the cost of the tool per hour and the wages of the laborer per hour. The tool costs a certain initial amount at its purchase, then is depreciated through a certain sequence of years while the laborer demands his hourly wages. Even if the tool is completely automatic the cost for the depreciation of the tool still remains.

Coming now to the main point of this reasoning, an attempt is made to condense all possible production costs to one term:

This term includes the cost of the tool in dollars per hour, direct labor costs, indirect labor costs, and other costs. Included in the cost of the tool are the initial cost, including interest on capital, depreciation of the tool, maintenance of the tool. The mathematical reasoning involved in determining the value of this term will be shown later.

We all know that the reason for contemplating the purchase of a new machine is either to cut production costs or to increase production. In cases where the desire is to cut production costs, the proposed tool is to be used to replace a worn-out tool which is no longer doing its job, or the new tool is a modern one which does the job more efficiently than the old obsolete tool. In most cases where a new tool is to be purchased there is a wide choice of tools from which to choose which will do the job. Provided we dispense with all individual feelings, such as the more or less famous make of the tool, its reputation, its appearance, and the like, there remain the following basic questions:

1 What is the initial cost of current tools?
2 How do the costs of the tools compare with those of my competitors' tools?
3 What price level has the tool to be loaded with for no profit and with certain profit conditions?

These questions can be resolved by applying the data given in Table 1 to the nomogram, Fig. 1.

Table 1 Nomogram Data

| | Item | Dimension |
|---|---|---|
| Initial cost | $A$ | $ |
| Depreciation factor | $a$ | % |
| Space requirement | $q$ | sq ft |
| Specific cost of floor space | $b$ | $/sq ft |
| Cost of energy (current) | $s$ | $/kwhr |
| Power consumption | $p$ | kw/hr |
| Utilization factor | $X$ | hr/year |
| Total debit cost per hour | $D$ | $/hr |
| Direct hourly wages | $t_1$ | $/hr |
| Indirect hourly wages | $K$ | $/hr |
| Unproductive wage factor | $z$ | $/hr |

The author will try to give a solution for all these variables as it is the aim of this treatise to stay within the bounds of dollars and cents by not using a subjective view which sooner or later always winds up in differences of opinion. From the first moment this aim will seem confusing. The whole problem, however, will appear more susceptible of solution if we start out by assuming the utilization factor as a function of annual expenses for the tool against the hourly expenses, which gives the following equation

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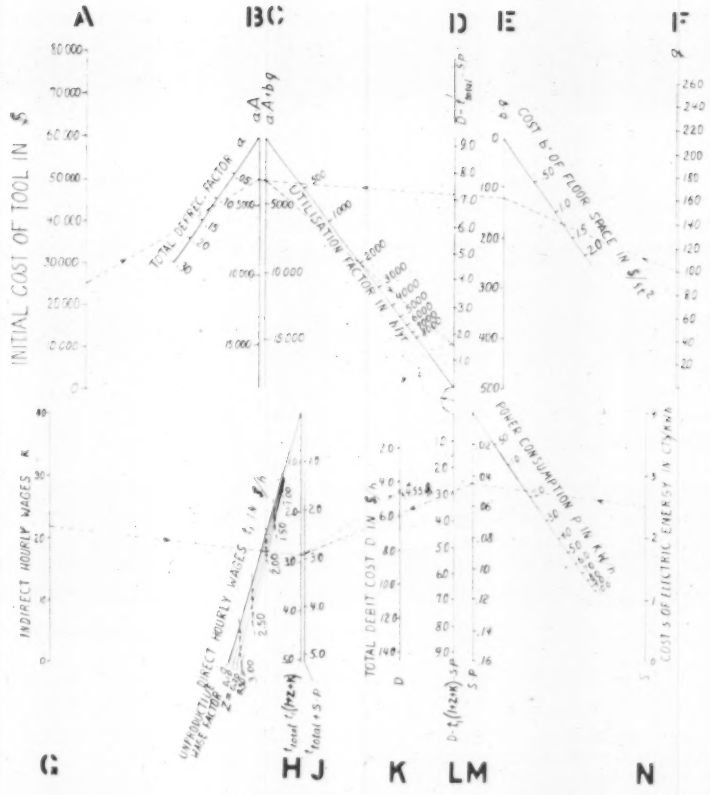


Fig. 1 Nomographic chart for analysis of cost of machine-tool operation

$$D = \frac{aA + bq + X[t_1(1 + z + K) + sp]}{X} \text{ in \$/hr}$$

$$X = \frac{aA + bq}{D - t_1(1 + z + K) - sp} \text{ in hr/yr}$$

where

$A$ = initial cost ..... in \$
$a$ = depreciation factor plus $^2/_3$ of rate of interest plus rate of repair work
$q$ = space requirement ..... in sq ft
$b$ = cost of floor space ..... in \$/sq ft
$X$ = utilization factor ..... in hr/yr
$D$ = total debit cost ..... in \$/hr
$t_1$ = direct hourly wages ..... in \$/hr
$K$ = indirect-hourly-wage factor
$z$ = unproductive wage factor
$s$ = cost of energy ..... in cents/kwhr
$p$ = power consumption ..... in kwhr

Example: Precision Boring Mill

$A$ = \$25,000
$a$ = 0.1215
$q$ = 100 sq ft
$b$ = 1.25 \$/sq ft
$X$ = 2000 hr/yr
$t_1$ = 2.20 \$/hr
$K$ = 0.22
$z$ = 0.10
$s$ = 2.5 ct/kwhr
$p$ = 1.8 kwhr
Result: $D$ = 4.55 \$/hr

$$\text{Utilization} = \frac{\text{annual expenses in \$/yr}}{\text{hourly expenses in \$/hr}}$$

The final result is in hours per year.

How we arrive at the specific mathematical terming of this equation will be shown in the following.

### Annual Cost and Depreciation Factor

It is not the aim of this paper to give a thorough analysis of the varying ways which decide the proper calculation of the depreciation factor. The following points, however, may help in summarizing this problem, although they are very well known everywhere in management. In the calculations any depreciation appears as a cost. In some cases, and especially when the balance of the year is in excess of expectations, there can be ordered extraordinary write-offs. This results in a decrease of the annual write-offs in later years. In extraordinary cases some tools may be depreciated to a low value or, for example, \$1.00. In this case no further deductions for depreciation would be made in the books. However, when calculating the cost of production, it wouldn't be fair to debit the product with excessive depreciation for any particular year. These calculations once made up should be followed as long as the tool is being used and regardless of the possibility that the books will show differently. This procedure will be followed in this scheme.

***Refinancing New Tools.*** Any amounts for depreciation are designed to refinance the purchase of a new tool. Therefore it is essential that there is enough capital on hand to procure a new tool considering the actual price of this new tool at the time of purchase. For this reason it is sometimes necessary to make allowances for fluctuations of prices in the open market. A careful management will always desire to follow any price fluctuation in the market, especially its effect on the cost of a new tool. As it is furthermore commendable to correct the amount of depreciation at least once a year, the management has the assurance that the depreciations made during a sequence of years surely will buy a new tool in due course.

The depreciation factor usually is termed in percentage of the value of the tool whether the price is the initial cost or the actual price of the tool. For an ordinary tool the depreciation time can be stipulated by 10 years and the depreciation factor is then 10 per cent or 0.10. It goes without saying that these factors have to be adjusted to the practical results. In case the tool in question shows heavy wear, the depreciation factor has to be increased and vice versa.

***Cost of Repairs.*** In addition to the depreciation factor there is the cost of the repair work. This is entirely a matter of experience and routine which every manager knows to close tolerances. Usually the cost for repair is almost nonexistent in the first years but picks up at an increasing rate in later years. In order to equalize an almost constant depreciation factor and a gradually increasing repair factor it would be most desirable to operate with as equal a combined factor as possible.

It is somewhat difficult to state the correct figures concerning depreciation factors as these are matters of personal judgment and experience, and furthermore

must be agreed to by the Bureau of Internal Revenue. Machine tools which are the subject of this paper will range between 5 and 10 per cent. Furthermore it must be decided whether a machine tool is fully satisfactory as to competing qualities or, maybe, has to be replaced much earlier in order to give way for a more effective and cost-saving one. With these remarks we can consider the matter of depreciation as settled.

***Interest Charges.*** Another point to be remembered is the calculation of interest charges. In many cases and especially where the production facilities are being extended, the management has to take up a loan for the purchase of new machine tools—and has to pay a certain rate of interest. Some specific remarks about this are in order.

If an outside loan has to be established, naturally the lender charges a certain rate of interest which then remains as a firm cost for the factory until the loan is paid back. This cost for the interest consequently must remain part of the production cost.

Provided the capital comes from the plant's own funds, this also has to be subject to interest charges if the structure of the factory is to remain sound. It is an ironclad rule that capital which can be disposed of should bring interest back into the plant. If the plant were unable to provide interest on its own capital, the stockholders would be at a loss, and this is an unhealthy development as a management that has come into this serious position would experience considerable difficulty in raising any additional funds. Yet it may be stated here that a company should prefer to use its own capital and pay interest to itself because any outside lending agency will demand some sort of security—usually the plant's assets—and in case of bankruptcy such agency is entitled to repayment ahead of the stockholders. It is, therefore, not only commendable but also strongly advisable that the management make allowances for these interests in all cost-accounting methods, whether its own or outside capital is involved.

***Estimating Interest.*** The originally invested capital is the price at the date of the machine-tool purchase plus the cost of duty, freight, erection, and so on. Let us assume that the price of a tool is $25,000. A 5 per cent interest on top of this figure would amount to $1250—for every year. This cannot be correct as no provision has been made for the depreciation during a sequence of years. This method would be proper when all depreciation sums would be put into a bank account, and the interest from this account would be deducted from the original value of the tool. As it is, nobody would act like this. Instead, the amounts owed to depreciation are usually invested in the same enterprise from which they came. In case we would estimate interest of these new assets again on top of the formerly mentioned assets we would suddenly have to face the fact that we estimated interest from both assets, which sounds absurd.

For the sake of simplicity and for the purpose of obtaining a practical and appropriate solution, there exists the possibility of multiplying the rate of interest—here called $c$—with a factor like $^2/_3$ wherein $c$ remains the rate of interest for the whole period depreciation is in effect. By this means we avoid overdimensioning the interest procedure as just explained. Thus assuming, e.g., that the rate of interest is 4.5 per cent we only account constantly for $^2/_3 \times 4.5 = 3$ per cent. For the final analysis of the total cost of machine tools we will avail ourselves of this method.

Previously we had mentioned the yearly cost for repair work. As the factor of depreciation and the rate of interest are suitably expressed in percentage this should be the proper term for the factor of repair work $g$. In order to make the final nomogram most applicable this factor will be set arbitrarily at 2 per cent constantly.

The final estimate for depreciation, interest, and repair work will assume the following shape:

The total depreciation $a$ will consist of the following factors

$$a = f + {}^2/_3\, c + g$$

where

$f$ = factor of depreciation
$c$ = rate of interest
$g$ = factor of repair

This factor $a$ multiplied by the total price of the new tool gives the yearly amount of depreciation.

The reason for having given these well-known facts a somewhat detailed explanation will be fully understood later when it has been shown that the total amount for depreciation has a somewhat dominating influence upon the production cost.

## Cost of Upkeep

As soon as the amortization plan comes into effect any machine tool will start running current expenses for upkeep, such as rent of floor space, heating, light at tool and in shop, insurance, electric energy, and so on. The last mentioned item will be treated separately.

In order to find a mutual base which facilitates a specific estimate of these current expenses, it is suggested here to convert these into cubic feet of shop volume or better into square feet of shop area. The latter method seems to be the most suitable one inasmuch as most of the modern factories consist of one-story buildings where the distance from the floor to ceiling remains uniform. This makes the shop volume identical with the floor area. Thus it seems appropriate to correlate the cost of upkeep for a tool with relation to the floor space it covers.

***Estimating Floor Space.*** When listing the space in square feet of a machine tool, the following items must be taken into consideration:

(*a*) The space requirement of the machine itself comprising all the tool's movements in a horizontal plane.
(*b*) Space for the machine goods awaiting their turn.
(*c*) Space for the laborer, his tools, and tool chest.
(*d*) Additional part of the unused space of the factory premises, eventually proportional space of office and all indirect space.

The practical procedure will be the following:

At first the direct space for the machine tool will be calculated according to (*a*), thereafter an additional space of approximately 30 sq ft will be added according to (*b*), and another 20 sq ft for the laborer himself. Finally the proportional space according to (*d*) will be added. The total space requirement will be termed $q$ and the dimension is in square feet.

***Current Expenses.*** While these details easily can be listed as they are a basic part of the factory organization it is somewhat more difficult to ascertain the cost of the

current expenses for a machine tool. There the experience of the management and the production engineer will be helpful. The following figures are approximate for such a calculation:

| | |
|---|---|
| Total rent of space | 17 $q$ |
| Heating | 8 $q$ |
| Ventilation | 2 $q$ |
| Overhead light | 4 $q$ |
| Light at machine tool | 4 $q$ |
| Insurance of tool | 1 $q$ |
| Diversified | 4 $q$ |
| Total | 40 $q$ ($/year) |

It will be evident that these figures will vary considerably in different factories. If we were to make a serious mistake in calculating the rent and maintenance cost, this error would not have disastrous effects in the final analysis as the cost of depreciation is so much greater that the costs just mentioned will only influence these costs in a minor degree, as will be proved in an example later. On the other hand it would not be wise to disregard even minor expenses considering that there are installed a multitude of machine tools even in an average-sized factory. Obviously such an error will multiply any mistake in the estimates by its numbers.

***Influence of Wage Factor.*** In the previous paragraphs we have discussed capital values which can be calculated rather simply. On the surface it would seem that the calculation of the influence of the wage factor on the production cost would be a more complicated task. However, this can be broken down into two major factors, type of machine tool, and general expenses of the factory. Thus to calculate the total debit cost per hour ($D$ = $/hr) we must know the following:

| | |
|---|---|
| Direct hourly wages | $t_1$ in $/hr |
| Indirect-hourly-wage factor | $k$ |
| Unproductive-hourly-wage factor | $z$ |

The total debit cost per hour ($D$) tells the management the nonprofit price of production in $/hr for any particular machine. The direct and indirect wages should then be converted to the same units; that is, $/hr. Other direct costs are those covering the material consumed or machined during the manufacturing process and the cost of energy. Cost of material can easily be traced separately and therefore can be excluded from the problem at hand. The most important direct cost is represented by the direct labor wages in $/hr which adds directly to the cost of the machine tool. In any factory there occur many forms of indirect wages, such as wages for foremen and general shop people, wages for office employees, and so on, general expenses as postage, telephone, insurance, fringe benefits, cleaning, and the like. All these expenses have to be taken into account remembering that all wages should be expressed in $/hr. These, of course, have to be debited to the direct wages. This seems quite logical inasmuch as the work produced by the machines represents the bulk of a factory's earning power.

## Applying the Method

In the following paragraphs an attempt will be made to compose a working scheme for any structure of a machine factory, large or small.

Provided the direct wages per laborer are termed $t_1$ ($/hr), or $T$ ($/year) and one year represents 2000 working hours the yearly wages per laborer will amount to

$$T = 2000 \times t_1 \quad [1a]$$

The indirect expenses can be divided into:

($a$) Wages for office employees per year, $L_1$ ($/yr).

($b$) Vacation pay for laborers, and fringe benefits, and the like.

($c$) Unproductive expenses; e.g., for administration and its branches.

Assuming that the number of laborers is $a$, the wages of these laborers are

$$L_2 = 2000 \times a\ t_1 \text{ ($/yr)} \quad [1b]$$

At this stage it has to be decided what type of factory is being dealt with.

It might be a small factory making screws on automatics, or it might be a motor-engine factory with considerable research facilities which will require a large staff of highly trained engineers. These conditions can be taken care of by establishing an indirect wage factor $K$

$$K = \frac{\text{indirect wages}}{\text{direct wages}} = \frac{L_1}{L_2} \quad [2]$$

which factor will tell clearly about the structure and general scheme of the factory in question.

It goes without saying that this factor $K$ should be kept low as the indirect wages are charged to the direct ones. Concerning a certain branch of manufacturing the indirect wages are supposed to remain in a certain relationship relative to the number of laborers, in which category laborers are considered as those who do productive work such as attending to the tool machines, erecting machinery, and so on. This relationship, of course, must not differ much in the organizational scheme of manufacturers making the same products. It is enlightening to analyze this factor $K$ for the most diversified fields of manufacturing. This, however, will not be discussed at this time as it does not deal directly with our topic and space is limited.

A multitude of examples shows that the factor $K$ in 90 per cent of all cases lies between 0.20 and 0.28. Furthermore, the factor is a major function of the laborers' wages as it increases with lower wages and vice versa. This phenomenon, however, is not directly applicable as it is a fact that in areas with low direct wages also will be found low indirect wages. The relatively narrow limits of the factor $K$ in most instances permits us to assume $K = 0.24$ for approximate estimates without making any calculations. This will hold true for any plant which has a sound financial structure.

The indirect wage factor $K$ also can be determined by the following equation

$$K = \frac{\dfrac{L_1 + L_2}{T_1} - t_1}{t_1} \quad [3]$$

where $T_1 = 2000\ a$; $a$ = number of productive laborers.

If we call the indirect hourly wages

$$t_2 = K\ t_1 \quad [3a]$$

then

$$t_2 = \frac{L_1 + L_2}{T_1} - t_1 \quad [4]$$

The part of the wages $t_3$ which corresponds to the vacation pay of the laborers is

$$t_3 = \frac{100\, a\, t_1}{T_1} \text{ and with } T_1 = a \times 2000$$

$$t_3 = \frac{100\, a\, t_1}{a \times 2000} = 0.05\, t_1 \quad [5]$$

In addition to these expenses another source of cost must be calculated which is called here the unproductive wage factor $y$ consisting of fringe benefits, postage, telephone, cleaning, building repair, and the like.

This part $t_4$ of the wages will then be

$$t_4 = y\, t_1$$

(For preliminary survey of the total cost this factor $y$ can be set at 0.05.)

The total hourly wages $t_{total}$ assume then the following equation

$$t_{total} = t_1 + t_2 + t_3 + t_4 \quad [6]$$

$$t_{total} = t_1 + \left(\frac{L_1 + L_2}{T_1} - t_1\right) + 0.05\, t_1 + y\, t_1 \quad [7]$$

or

$$t_{total} = \frac{L_1 + L_2}{T_1} + (0.05 + y)t_1 \quad [7a]$$

Let the term $(0.05 + y) = z$; then $z$ represents the combined unproductive wage factor. Thus our Equation [7*a*] reduces to

$$t_{total} = t_1\,(1 + z + K) \quad [7b]$$

The total debit cost per hour is reduced by $t_{total}$ and the cost of energy $ps$ consumed, wherein $p$ represents the average power consumption in kilowatts and $s$ the specific cost of energy in cents/kwhr. Provided it is necessary to establish the average cost of energy per hour for a machine tool having intermittent power consumption, then the only way to average this cost is to make proper time studies for an actual machining process. This procedure, however, is often complicated unless the management uses modern production-engineering methods and prescribes a detailed working scheme for most of the tools. Provided the cost of energy remains an essential part of the cost such as for electric hand tools, it is advisable to connect a recording wattmeter to the circuit of the tool and thus average the power consumption for some length of time. In other uses where the power consumption is of less importance this cost can be estimated easily.

A profit $V$ any tool makes can be expressed as follows

$$V = D - t_{total} - ps \quad [8]$$

This equation will give the profit in the unit \$/hr which decidedly is an advantage.

The final utilization factor $X$ which decides the number of hours per year in which a tool has to be worked in order to pay for itself after a sequence of years can then be expressed by the following equation

$$X = \frac{aA + qb}{D - t_1(1 + z + K) - ps} \text{ hr/yr} \quad [9]$$

By transforming Equation [9] the total debit cost per hour ($D$) can be decided by

$$D = \frac{aA + qb + X[t_1\,(1 + z + K) + ps]}{X} \text{ \$/hr} \quad [9a]$$

Equations [9] and [9*a*] have 10 variables which can be divided into variables belonging to the basic tool such as $a$, $A$, $q$, $p$ while the other variables belong to the shop itself such as $b$, $t_1$, $(z + K)$, $s$. For a certain machine shop the variables $b$, $t_1$, $(z + K)$, and $s$ are constant for all tools under that period where no major changes are being made in the shop's basic organization.

For a machine tool the variables $A$, $q$, $p$ can be taken from a catalog. The depreciation factor $a$ has been discussed before and can therefore be decided accordingly. The initial cost including additional tools, insurance, freight, and erection can be estimated easily. The only uncertain variable is the power consumption which has been mentioned previously. In order to demonstrate the application of Equations [9] and [9*a*], respectively, let us calculate a machine tool accordingly.

### Using the Nomogram

Equations [9] and [9*a*] are not so practical for shop use. They are, therefore, presented in a nomographic chart, Fig. 1, which gives the proper solution for all 10 variables. The nomographic chart is designed in such a way that the numerator of Equation [9] remains on the upper part of the nomogram while the calculation of the denominator is performed in the lower part of it. Typical for the nomogram, furthermore, is that the analysis operation can be started from any part of the chart until finally the axis is reached which gives the value of the unknown variable. Another advantage of the nomographic chart is incorporated in the fact that even in those cases where the exact factors are uncertain the operation still can be performed by using a limit of the unknown factor and thus wind through the chart with two values of a factor. The result will then show two values due to the limiting of an approximate factor.

A line drawn from the scale $A$ to the value of the depreciation factor will multiply these two values on scale $B$. This point has to be marked. Moving to scale $F$ a line is drawn through the scale of the cost of floor space which will give the product of this multiplication on the scale $E$. The points of scales $B$ and $E$ are now connected and perform an additional process on scale $C$. This new point on scale $C$ is connected with the proper utilization factor and is projected to scale $D$. The distance of this point of intersection from the origin $O$ is then transferred to scale $L$ by the arc of a circle about the origin $O$. The scale $L$ gives the reciprocal value of scale $D$. The new point on scale $L$ is marked again while the rest of the operations are going on. Choosing $K$ on scale $G$ and the direct wages $t_1$ as well as the unproductive wage factor $z$ renders the total hourly wages on scale $H$ which point also is marked. Moving over to scale $N$ the value of the cost of the electric energy is connected with the value of the power consumption and projected to scale $M$ gives their product in which both values are multiplied on scale $M$. The points on scale $H$ and $M$ are connected. This manipulation adds them on scale $J$. Finally, a connecting line is drawn from scale $J$ to $L$ which intersects scale $K$ at a certain point which gives the true cost of the machine tool in \$/hr.

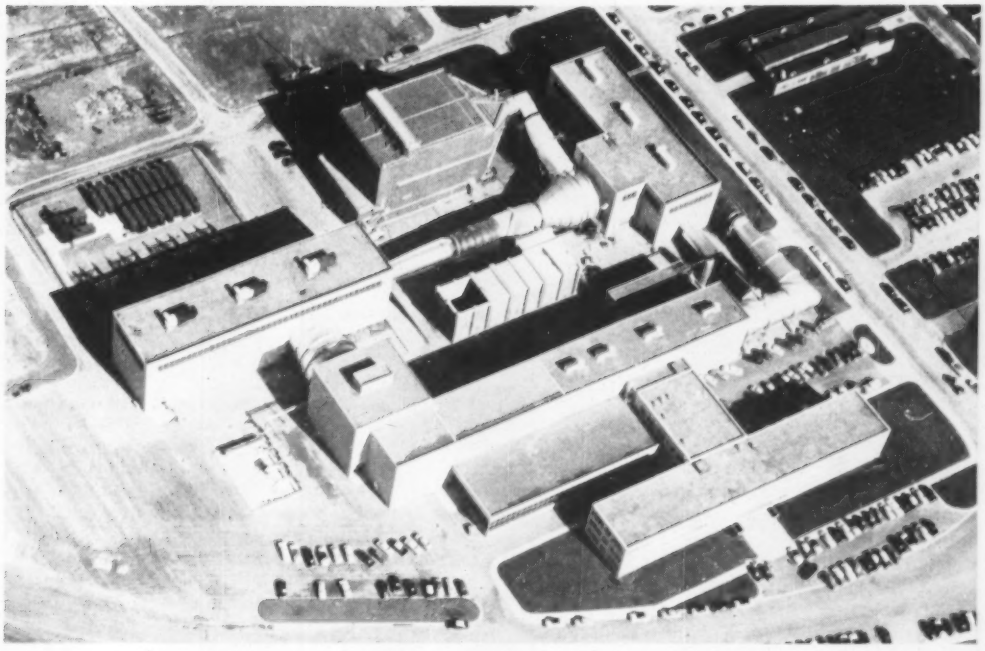

Fig. 1 Air view of 10 × 10 supersonic wind tunnel at Lewis Flight Propulsion Laboratory, Cleveland, Ohio

# Propulsion Wind Tunnel

## *at NACA Lewis Laboratory*

### Details of 10 X 10 supersonic tunnel covering Mach-number range of 2.0–3.5

**By E. W. Wasielewski**

**Assistant Director, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio**

THE 10 × 10 supersonic wind tunnel at the Lewis Flight Propulsion Laboratory, Fig. 1, is one of the tunnels authorized by the Congress in the Unitary Wind Tunnel Plan Act of 1949. The primary purpose of this act was to provide facilities for testing experimental models in connection with the development of aircraft and missiles. The sum of 75 million dollars was appropriated on June 29, 1950, to the National Committee for Aeronautics for the construction of the following wind tunnels:

1 An aerodynamic tunnel at the Langley Memorial Laboratory (nominal test-section dimension, 4 ft) having a Mach-number range from 1.5 to 5.0.

Contributed by the Aviation Division and presented at the Semi-Annual Meeting, Cleveland, Ohio, June 17–21, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper No. 56—SA-58.

2 An aerodynamic tunnel at the Ames Aeronautical Laboratory (nominal test-section dimension, 8 ft) with a Mach-number range of 0.8 to 3.5.

3 A 10 × 10-ft propulsion wind tunnel at the Lewis Flight Propulsion Laboratory covering a Mach-number range of 2.0 to 3.5. Approximately 33 million dollars was allocated for this tunnel.

This tunnel will be used primarily for the investigation of propulsion problems connected with turbojet and ramjet engines, such as inlet and outlet-design investigations, engine-matching studies, and interference effects. Although it is expected that much of the testing will be done with models, special attention also has been given to the possibility of testing full-scale turbojet and ramjet engines. While tunnel-wall effects made it impossible to obtain complete information from the tests of such engines, valuable data can be obtained on inlet problems and engine operation. There is ample evidence to demonstrate that the rate of development of such engines is strongly influenced by the facilities available for testing them at full scale.

The 10 × 10 supersonic wind tunnel supplements the 8 × 6 wind tunnel (Mach-number range 1.4 to 2.0) which has been in operation at the Lewis Flight Pro-

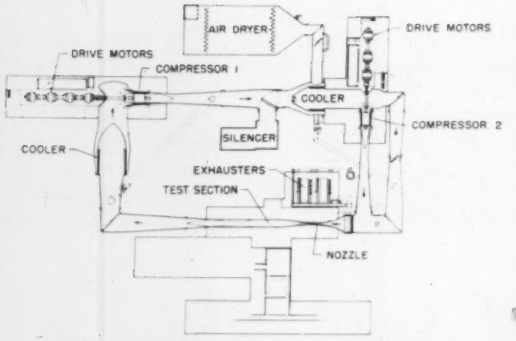


Fig. 2 Schematic diagram of 10 × 10 supersonic propulsion or aerodynamic wind tunnel

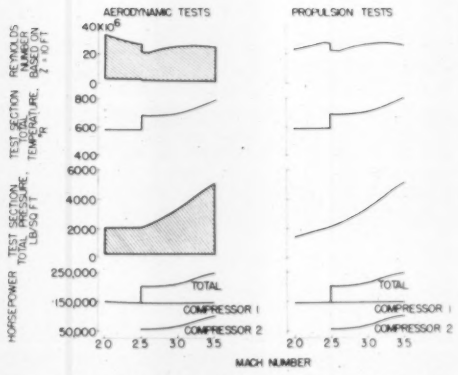


Fig. 3 Operating characteristics of wind tunnel

pulsion Laboratory for several years. The experience obtained in the design and operation of the 8 × 6 supersonic wind tunnel has been used extensively in the design of this new facility.

In the description that follows, special attention has been given to the methods of design and problems encountered. Selected test data also have been included in order to give an idea of the scope of the design and development work that is required.

## General Arrangement and Performance

Two compressors were selected to cover the Mach-number range of 2.0 to 3.5 (Fig. 2). The tunnel can be operated either as a propulsion wind tunnel (open circuit) or as an aerodynamic wind tunnel (closed circuit) depending upon the position of the 24-ft diversion valve which is downstream of compressor No. 1. With the valve in the position indicated by the dotted lines, the tunnel operates as a propulsion wind tunnel. Air is drawn from the atmosphere through the drier and cooler.

In the Mach-number range 2.0 to 2.5, compressor No. 2 is stationary and the air passes through a by-pass leg; at higher Mach numbers the valve in the by-pass leg is closed and the air passes through compressor No. 2 to the plenum chamber where a flow straightener and three sets of screens make the flow uniform and reduce the turbulence. The desired Mach number is obtained in the flexible nozzle, and the air then passes through the test section to the second throat and subsonic diffuser which convert the velocity to pressure. Heat added by the compressor or by the model under test is removed in a cooler, and the air is pumped back to the atmosphere through a silencer by compressor No. 1. For aerodynamic operation, the diversion valve closes the opening to the silencer, the valve from the air drier is closed and the tunnel operates with a closed circuit. The pressure level in the tunnel can then be regulated by means of the exhausters which are located near the flexible nozzle. In order to provide for proper compressor matching as well as to prevent surging under emergency conditions, bleeds (indicated by dotted line in Fig. 2) are provided around both compressors. The valves in the bleed line are quick-acting valves that can be used to bring the shock waves through the test section rapidly when the tunnel is being started.

Although the tunnel can be started either as a propulsion tunnel or as an aerodynamic tunnel, it is most often started as an aerodynamic tunnel and switched to propulsion operation by moving the diversion valve after the tunnel has been brought to full density. This procedure permits better control of the large amount of power involved and reduces the magnitude of the starting load to which the model must be subjected.

The conditions obtainable in the test section and the amount of power required to run the tunnel are shown in Fig. 3. Of special interest is the test-section total pressure under propulsion operation. Although a tunnel of this size covering this Mach-number range could have been built with a single compressor, the need for maintaining realistic test-section pressures for operation with a burning engine was a major factor in establishing the tunnel arrangement with two compressors.

Experience with the 8 × 6 wind tunnel indicates that the test program calls for having an engine under operating conditions in the tunnel only about 50 per cent of the time. The closing of the tunnel therefore increases its utilization by permitting more running time during the summer months when propulsion runs are usually limited by the drier capacity. In addition, of course, a large range of altitude can be covered, as shown in Fig. 4. Only a small amount of altitude variation is obtainable under propulsion operating conditions, as shown in Fig. 5. Altitude variation in this case is obtained by inlet throttling and by adjusting the speed of the compressors; the amount of variation obtained is strongly influenced by the model size and the curves shown in Fig. 5 apply principally to the smaller models.

## Air Drying

Although all supersonic wind tunnels require dry air, the problem is especially critical in open-circuit propulsion tunnels like the 10 × 10 supersonic wind tunnel where the full air flow must be dried. As a result, the cost of drying is very great (approximately two and one half million dollars was spent on drying equipment for this tunnel) and careful attention must be given to drier design and desiccant selection. Practical experience indicates a dew-point requirement of —40 to —50 F; after an extensive test program, activated alumina was selected as the desiccant material.

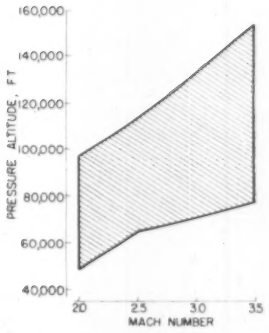


Fig. 4 Aerodynamic altitude range

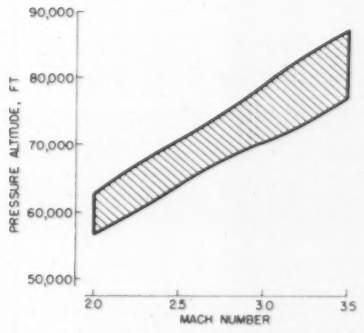


Fig. 5 Curves of propulsion altitude range

The general arrangement and operation of the air drier is illustrated in Fig. 6. During normal operation valves a, b, and d are closed, and the air passes directly through the filters and drier beds into the tunnel. After the bauxite has become saturated with water, it is put on a reactivating cycle by closing valves b, c, and e. During this cycle air is drawn in through the filters by the fan, through the burners (the coolers are not operative in this cycle), the beds, and out through valve e. The burners heat the air to approximately 400 F so that the moisture can be driven off. The beds are then cooled by running the fans in the reverse direction with only valve b opened; during this operation the coolers remove the heat from the beds. During the winter adequate drying capacity is available to take care of runs up to 10 hr, but on humid summer days running time of the propulsion circuit will be limited to approximately 2 hr. In order to conserve running time during the summer season, the drier can be by-passed during the starting period through valves a and c.

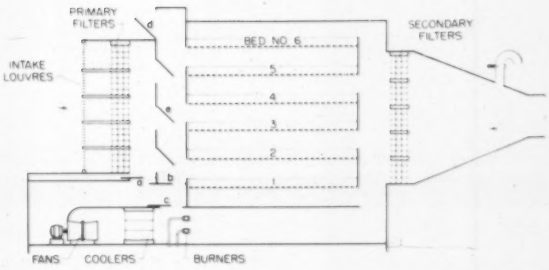


Fig. 6 Schematic diagram of air drier for the wind tunnel

### Air Cooling

All the heat which is generated in the tunnel either by the compressors or by a model in the test section is dissipated through a cooling tower having a capacity of approximately 900 million Btu per hr. For most normal testing adequate cooling capacity is provided in both coolers Nos. 1 and 2 to take care of the heat loads. When large engines with exhaust temperatures in the range of 3000 to 3500 F are under test, however, the surfaces of cooler No. 1 must be supplemented by a water spray at the downstream end of the test section. This spray not only provides additional cooling capacity but also holds down the temperature of the second throat and the diffuser section. The effect on compressor No. 1 is small and easily accommodated. The use of the spray reduces the expansion-joint problem in the diffuser section of the tunnel, and satisfactory sealing in the second throat section is more easily obtainable.

Both coolers are of the extended-surface type using plate fins with the water tubes running parallel to the center line of the tunnel instead of the more conventional arrangement where the tubes run perpendicular to the center line of the tunnel. In general, this arrangement trades length for diameter; it is attractive in this case because the length of the tunnel is determined by other considerations, and the required cooler length can be accommodated easily. An auxiliary benefit is obtained from a service standpoint because the number of field joints is minimized and the possibility of water leakage into the tunnel is therefore greatly reduced.

### Nozzle, Test Section, and Second Throat

A general view of the flexible wall nozzle, with the test section in the background, is shown in Fig. 7. The nozzle wall is a plate approximately $1^3/_8$ in. thick which is flexed by means of jacks mounted at 27 stations along the nozzle. The position of the wall is determined by a shaft having a cam at each jack station. One of these cams can be seen in the foreground. The cam operates a pilot valve at each jack station; the pilot valve in turn admits oil to hydraulic motors which drive the jacks to the position called for by the cam. A rocker joint is interposed between the jack and the plate in order to make sure that only forces perpendicular to the plate are imposed.

The aerodynamic design of the nozzle was determined by the method of characteristics. By placing the geometric point of inflection ahead of the characteristic point a smooth contour was obtained. Corrections for boundary layer were made in both the nozzle and test section.

The test section itself is 10 ft × 10 ft in cross section and 40 ft long. Provisions have been made for mounting models in the top and bottom of the tunnel. Flexibility in placing the model longitudinally is obtained by a series of removable plates mounted in the bottom and top plates. For the largest models which will be encountered, the bottom plate can be lowered for easy

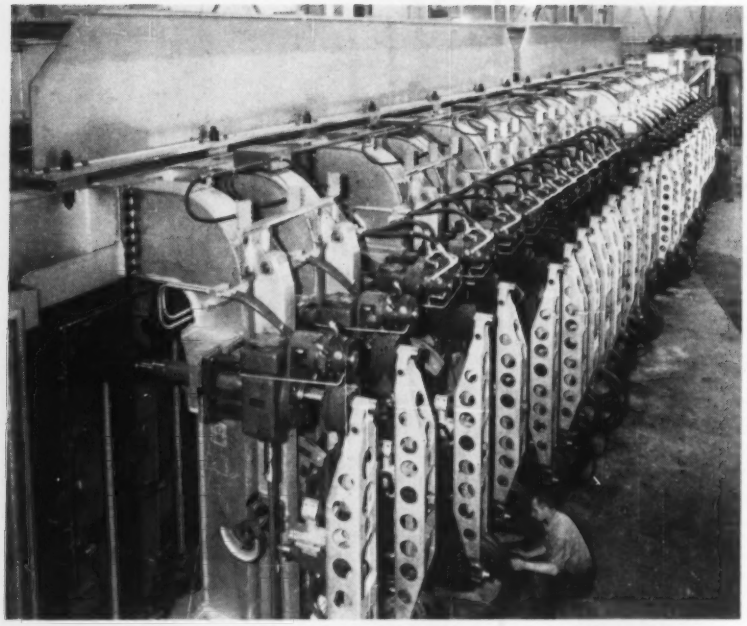

**Fig. 7 General view of flexible nozzle of the 10 × 10 supersonic wind tunnel**

access to the model and its mounting. Three openings are provided on each side of the test section for schlieren and direct observation. All observations are transmitted to the main control by means of television cameras.

To reduce the pressure ratio required, especially at the higher Mach numbers, a variable second throat has been provided. By means of jacks at a single station, a pin joining two plates is moved toward the tunnel center line so that the upstream plate forms a converging passage while the downstream plate forms a diverging passage. The second throat is followed by a transition section and subsonic diffuser.

To check the performance of this combination, a one-tenth-scale pilot tunnel was tested. The results, Fig. 8, established the minimum pressure ratios for the compressor design as well as the area schedule for the second throat. Similar tests were conducted with various models under both starting and running conditions.

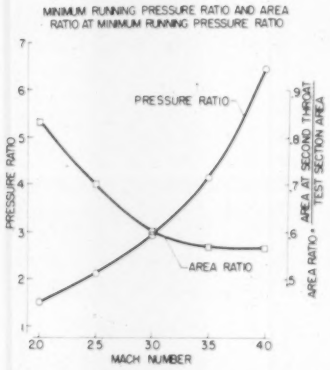


**Fig. 8 Performance of the pilot tunnel**

## Compressors

Compressor No. 1 has a capacity of 4,625,000 cfm and a maximum pressure ratio of 2.8. It requires 150,000 hp to drive this compressor at 865 rpm. The inside diameter is 13.6 ft and the diameter at the tips of the blades is 20 ft. Eight stages of compression are employed. Compressor No. 2 has a capacity of 1,350,000 cfm and a pressure ratio of 2.4. The power required is 100,000 hp at 855 rpm. The inside diameter of this rotor is 11.9 ft and the outside diameter at the tips of the blades, 14.9 ft. Ten stages of compression are employed. It can be seen that the design of compressor No. 2 is more conservative than the design of compressor No. 1. This was a matter of design choice which involved comparing a large compressor with a small compressor-plus-gearbox combination. General mechanical construction of these compressors is illustrated in Fig. 9 which shows a cross section of compressor No. 1. The compressor rotor consists of a number of disks which are held together by through-bolts near the outside diameter. The thrust bearing is placed outside the tunnel near the drive motors.

Both compressors were designed using NACA cascade data. A wheel-plus-vortex type of velocity distribution was used in the design. The maximum values of solidity and camber were held to 1.2 and 1.4, respectively. The maximum-blade-section Mach number is 0.70. Considerable attention was given to off-design conditions because of the large operating range required, especially in the case of compressor No. 2. The performance obtained with compressor No. 2 is shown in Fig. 10.

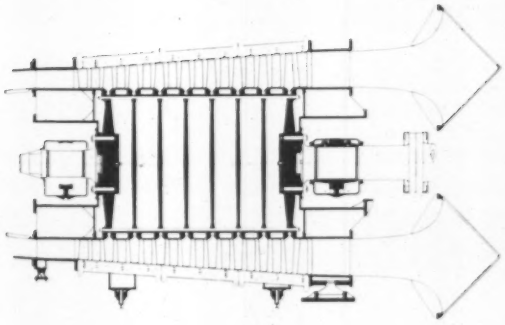

Fig. 9 General mechanical construction of compressors is illustrated by cross section of No. 1

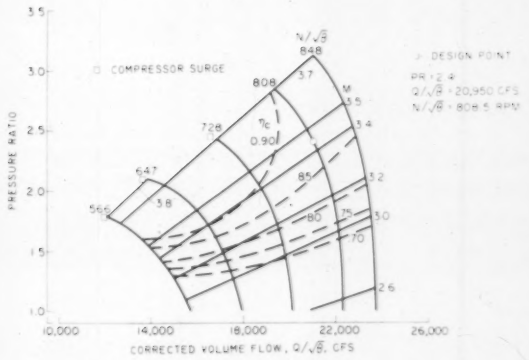


Fig. 10 Measured characteristics of compressor No. 2

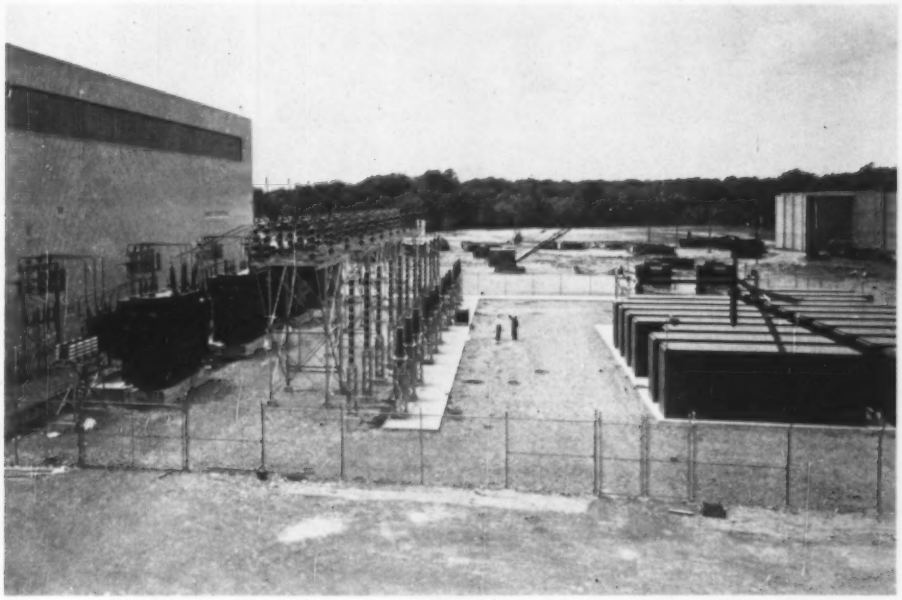

Fig. 11 View of project substation for the NACA unitary plan 10 × 10 supersonic wind tunnel

## Electrical System

Power for the project is brought from the main substation at the NACA Lewis Flight Propulsion Laboratory at 132,000 volts, through an underground tunnel, to transformers located next to the largest drive system. Each of the four transformers, Fig. 11, is rated 60,000 kva and has three windings. One output winding furnishes power to the motors at 6900 volts while the other winding provides for interconnection to the other electrical systems at the Lewis Flight Propulsion Laboratory at 34,000 volts. Also shown in Fig. 11 are banks of capacitors; the power correction provided by these capacitors is a necessity for satisfactory voltage regulation.

The No. 1 drive is composed of three wound-rotor motors each rated 37,500 hp with a short-time rating of 45,000 hp; the No. 2 drive consists of three motors each rated 33,300 hp with a short-time rating of 39,800 hp. Control of speed is obtained by the use of liquid rheostats in conjunction with the wound rotor. Good speed control is possible at low speeds and loads by dropping motors from the circuit. The No. 2 motor-drive system is shown in Fig. 12. Although many electrical design problems exist in a power system as large as this one, special attention has to be given to the effect of this system on the public utility supplying the power for the project, since this load represents approximately 10 per cent of the utility company's present capacity. An analog-board study of the drive system together with the utility power system was found to be essential in determining the problems which would exist and the corrective measures which could be used to best advantage.

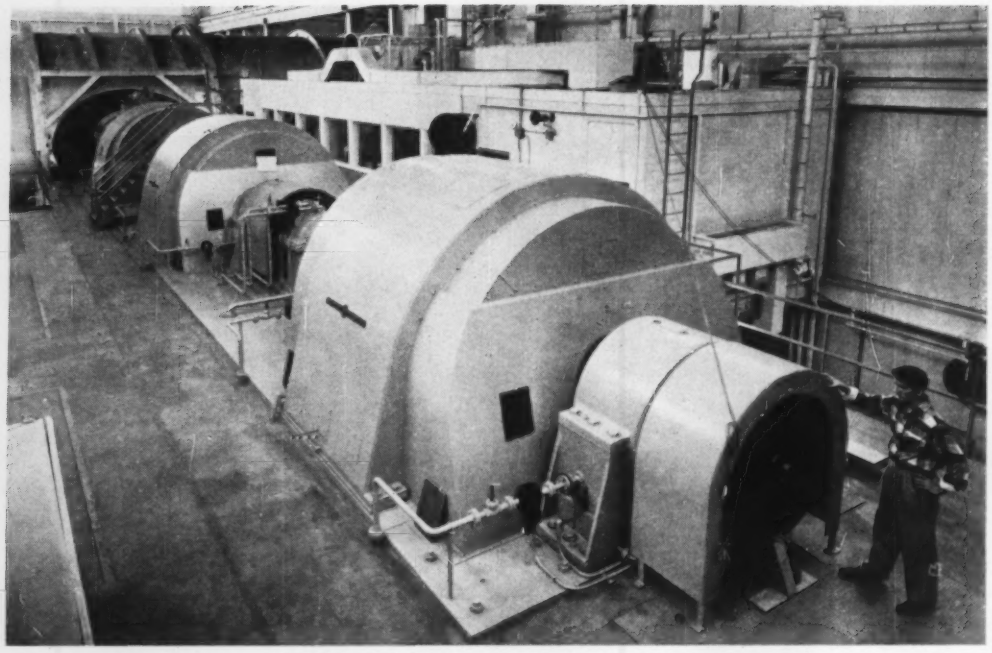

Fig. 12 No. 2 motor-drive system of 10 × 10 supersonic wind tunnel consists of three motors each rated 33,000 hp with a short-time rating of 39,800 hp

## Noise Reduction

Measurements made on wind tunnels and engines indicate that the noise intensity in the test section is between 160 and 180 decibels. A typical spectrum is shown in Fig. 13. Experience has shown that there is, in addition, considerable noise generated in the frequency range below 10 cycles.

Attenuation is obtained by using thick steel (1-in. minimum) plus enclosure or acoustical wrapping of critical sections. Propulsion operation introduces the necessity for sound absorption, especially the low-frequency noises mentioned; for this purpose, deep coverings of fiberglas have been installed in the section immediately upstream of compressor No. 1, and a serpentine fiberglas lining has been installed at the tunnel exit.

Although every noise problem must be treated with full consideration of environmental conditions, it has been found that satisfactory operating conditions are obtained at the Lewis Laboratory when the sound level in the immediate project vicinity is approximately 100 decibels.

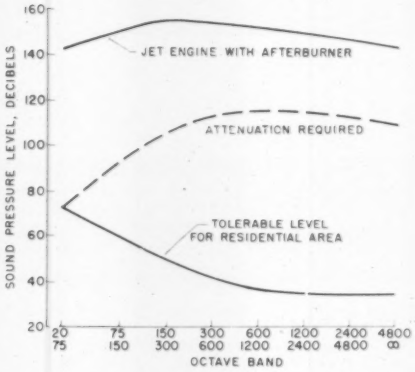


Fig. 13 Noise attenuation requirement for typical engine

## The Completed Facility—Concluding Remarks

The design of a large propulsion facility like the 10 × 10 supersonic wind tunnel involves highly skilled design work in nearly every branch of engineering. The simplest possible over-all arrangement which will produce the desired results is a necessity; careful co-ordination of the various phases of the work must be carried out and test programs directed toward solving the problems encountered should be performed in order to insure a practical operating facility. The completed wind tunnel with associated model preparation shop and office building is shown in Fig. 1. The tunnel control room and automatic data recording and computing equipment are located in the tee of the office building adjoining the tunnel test section. Satisfactory operation of the wind tunnel was achieved after a relatively small amount of shakedown running and correction of minor mechanical difficulties. The tunnel is now being actively utilized in research and development on supersonic aircraft propulsion systems.

# Alignment Diagrams From Network Charts by Graphics

*An exact graphical method—requiring no knowledge of nomography—which is quick, uniform, and as accurate as the plotted network chart and drafting warrant*

**By Douglas P. Adams**

Associate Professor, Engineering Graphics,
Massachusetts Institute of Technology, Cambridge, Mass.

LET us assume that we have been given a network chart as shown in Fig. 1(*a*). Whether this was plotted from an equation of the form $F(U, V, W) = 0$ or plotted from empirical data, we are interested solely in getting from it an alignment diagram showing the same behavior between the variables. By an alignment diagram is meant a set of three graduated scales, one for each variable, so contrived that any straight line which cuts all three scales does so at values of the variables that satisfy their equation or relationship. Fig. 1(*b*) is the desired diagram. The utility of this kind of diagram is well established and the sole question remains as to how Fig. 1(*b*) came to be "so contrived" from Fig. 1(*a*).

There are three reputable ways of constructing alignment diagrams, (*a*) the Euclidean method,[1] (*b*) the determinant method, and (*c*) the line-to-point method (on which this paper is based). The first two apply only when alignment diagrams are sought for known equations and they both require a certain minimum of experience and study. In contrast, the line-to-point method applies to an equation or empirical relationship and requires merely that this shall have been placed in network-chart form.

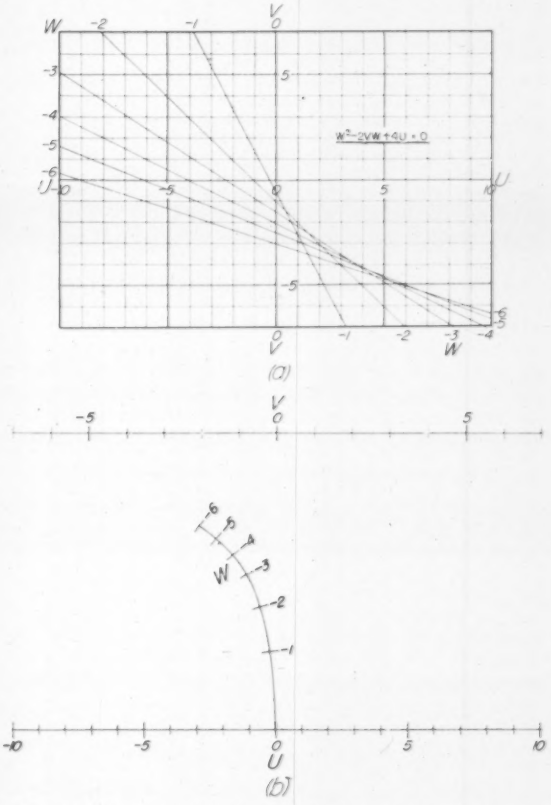


**Fig. 1** (*a*) **A conventional network chart. It happens to be made for the equation shown but, for our purposes, could represent an empirical relation between the variables. Note that only *W* — lines are shown.** (*b*) **An alignment diagram for the same relation.**

### Line-to-Point Method

The line-to-point method, the basis of the scanner process in this paper, seeks to derive from the *lines* of any network chart $N$ the points of a corresponding diagram $A$. We assume that the network chart is like Fig. 1(*a*); that is, it has $U$ and $V$ as primary variables running as shown, with $W$ as the dependent "family" variable and, for the moment, consisting of straight lines. When $U$, $V$, and $W$ lines concur at some point $P$ in $N$, their values satisfy the given equation or relationship. When $U$, $V$, and $W$ points are collinear in some line $L$ of $A$, their values similarly satisfy the equation or relationship. There are several ways both graphical and analytic of generating, $U$, $V$, $W$ points of $A$ from the $U$, $V$, $W$ lines of $N$ so that concurrency of the latter will bring the desired collineation of the former and the reverse. The scanner method of this paper is one of these graphical ways.

### The Scanner

The scanner (Fig. 2) consists of a transparent disk $D$ of rather stout plastic sheeting attached to a rectangular piece $S$ of the same material by a joint at $C$ so that the disk can turn about $C$ but will not wear loose with time. Through point $C$ lines $L$ and $M$ are ruled at right angles on disk $D$. Slider $S$ is intended to slide along a T-square. It has a line $X$ parallel to its lower edge and two congruent vertical scales $Y'$ (distant $m$ from $C$) and $Y$ (along the right edge.)

[1] The texts listed under References at the end of this paper refer to both the Euclidean and determinant methods. The line-to-point method, which regards point and line as *dual* elements, is referred to by d'Ocagne, nomography's leading authority ("Traité de Nomographie," Gauthier Villars, Paris, 1920). Nothing comparable to the scanner method has been found there by the author.

Contributed by the Machine Design Division and presented at the Semi-Annual Meeting, Cleveland, Ohio, June 17-21, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper No. 56—SA-39.

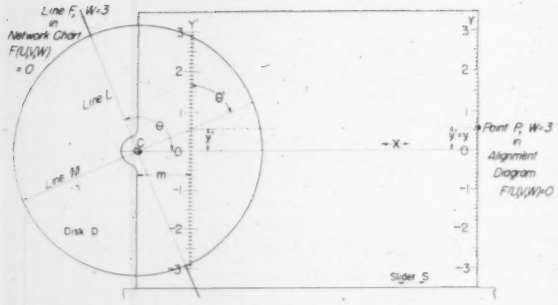


**Fig. 2 The scanner consists of a slider *S*, free to slide along the top of the a T-square and disk *D* fastened to *S* by a pivot joint at *C*. The network chart should preferably be placed on the board so that line *X* covers one of its diagonals. Various nonrectangular alignment diagrams will arise from different placement.**

The scanner is used as follows (Figs. 2 and 3): A network chart $N$ to be transformed to an alignment diagram $A$ is fastened on the drawing board so that one diagonal lies underneath line $X$ of $S$. With $S$ free to slide and $D$ to turn, let line $L$ of disk $D$ be placed in careful coincidence with some line $F$, say, $W = 3$, of $N$. Let $Y_3'$ be the height at which scale $Y'$ is now cut by line $M$. Then point $P$, the desired point of alignment diagram $A$, occurs on scale $Y$ at the same reading $Y_3' = Y_3$. $P$ should be marked $W = 3$. The process is continued until each line of $N$ has given rise to a point of $A$.

In Fig. 3, a network chart and scanner (dotted) are shown in conventional position together with the resulting alignment diagram. Line $W = 3$ is shown being carried into point $W = 3$. All the $U$ lines of $N$ have the same slope, hence all the $U$ points of $A$ will have the same height above line $X$ and the $U$ scale will not only be straight and parallel to line $X$, but also will be similar to the $U$ scale along the $U$ axis of $N$. The same is true for $V$. Hence a common property of alignment diagrams obtained in this way is that they have parallel scales which fill a rectangular space and are similar to the original axis scales of $N$.

The height of any point of $A$ above line $X$ is $Y' = m \cot \theta$ where $\theta$ is the slope angle of the corresponding line of $N$. For small enough $\theta$, the $Y'$ co-ordinate clearly becomes too large for the diagram. In Fig. 3 the $W$ lines ($W +$) of the upper half of the chart $N$ are of interest. Fig. 3 should be compared with Fig. 1, where the $W$ lines ($W -$) of the lower half of the $N$ diagram were of interest. A different tilt of $N$ was obviously used in Fig. 1(*b*) to avoid low values for $\theta$ there. The other diagonal lay along $X$. If any $W+$ lines had been plotted in the network chart of Fig. 3, they would have given rise to $W +$ points falling outside the bounds of the present rectangular alignment diagram of that figure. In case both the positive and negative values of $W$ had been present on $N$, as in Fig. 4(*a*), it is now clear that both the alignment diagrams, Figs. 1(*b*) and 4(*b*), would ordinarily have been required. This is a characteristic of alignment diagrams and is not a failing of the scanner method.

Fig. 4(*b*) is a conventional alignment diagram for the quadratic. The $V$ of Figs. 1(*b*) and 3 has been replaced by $a$, the $U$ by $b$, the $W$ by $x$. An up-down mirror image of the alignment diagram of Fig. 3 produces Fig. 1(*b*) with the $W$ and $V$ scales reversed in sign. Fig. 4(*b*) combines these diagrams and uses these facts.

## Technique of "Cross Firing"

The scanner method has proved the proposition that for a network chart whose $W$ family is straight lines, if the $U$ and $V$ "scales" of the network chart $N$ are enlarged to equal length and placed a desirable distance apart, the $W$ scale of points in $A$ can be found exactly by a cross-fire method. In this method, a pair of $U$, $V$ values consistent with the desired $W$ values (as read off $N$) are joined by a line and now two or more such cross-fired lines pinpoint the desired $W$ point on $A$. This technique has been used by knowledgeable persons who wanted alignment diagrams in a hurry. The method of this paper will produce the same result faster and a great deal more neatly.

The technique of cross firing has been abused by persons who failed to realize that the $W$ family of $N$ had to consist of straight lines before the method could be effective. Where the $W$ family consisted of curves, such persons found that no matter how carefully they cross-fired, the lines did not fix a point but appeared to spell out a curve to which they were tangent.

Fig. 5 shows the proper alignment diagram for such a network chart. The more gradual the curves of $N$,

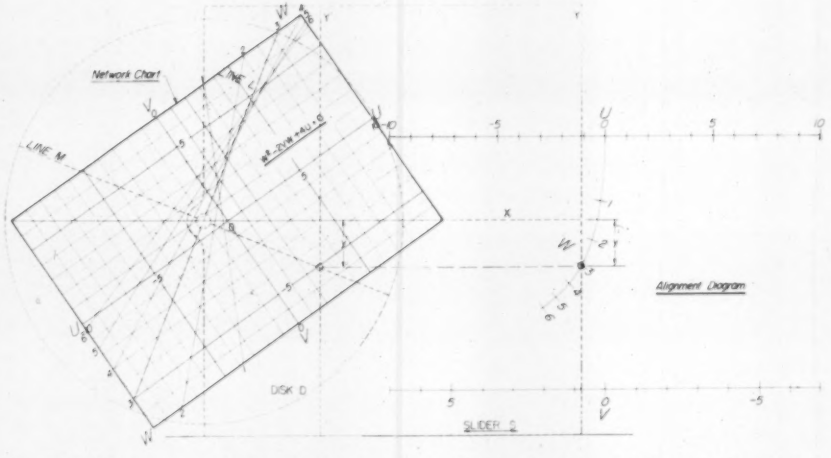


**Fig. 3 With the network chart in the proper position, *S* is slid and *D* turned until line *L* coincides with some line ($W = 3$) of the network chart. The reading of line *M* on scale *Y'* is then recorded on scale *Y* to yield point *P* of the alignment diagram ($W = 3$). Each line of network chart *N* is so treated. Only $W +$ lines are shown because $W -$ lines would give points outside the rectangular diagram.**

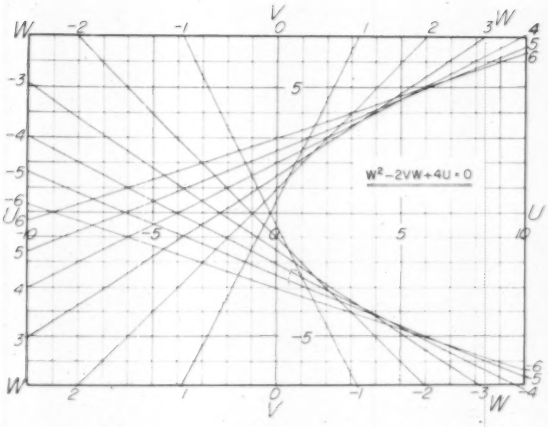


Fig. 4(*a*) A network chart is shown here with both $W+$ and $W-$ values on it

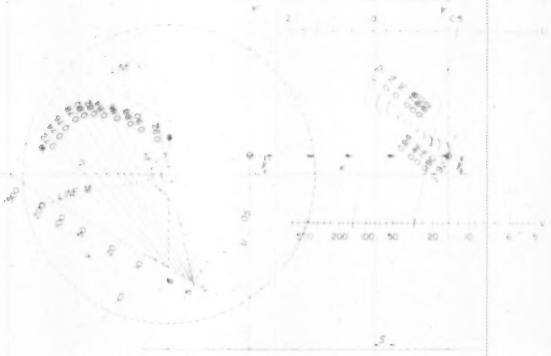

Fig. 5 Here the network chart $N$ contains curves which cannot be or have not been straightened. Line $L$ is made tangent to such a curve repeatedly, and the corresponding points of $A$ permitted to spell out the curve of $A$ corresponding to that of $N$. A line joining $U$, $V$ values is tangent to the $W$ curve, drawn or interpolated, which is the answer value. Two solutions are shown on both the network and alignment diagrams.

the sharper the derived curve of $A$. The sharper the curves of $N$, the more gradual the derived curve of $A$, there being a rough reciprocal relation between the curvatures in $N$ and $A$. *It is clear abuse of the method to approximate the curve in A by a point.* The correct procedure would have been to draw each derived curve of $A$ as the envelope of the cross-fire lines. The scanner method, Fig. 5, substitutes for this awkward, laborious derivation process the simple device of bringing the line $L$ of $D$ into positions of tangency to the curve of $N(W = 3)$ and marking the corresponding point of $A$ until the curve of $A$ $(W = 3)$ is smoothly spelled out.

It is often possible to "rectify" completely the curves of $N$ and this should always be done,[2] for the resulting conventional alignment diagram is superior to a quasi-alignment diagram.

Fig. 6 shows several familar types of network chart for the equation $E = IR$ and the forms of alignment diagram (not to scale) that they generate. In (*c*) a reciprocal scale for variable $V$ of the network chart

[2] "The Construction of Nomographic Charts," by F. T. Mavis, International Text Book Company, 1939, Chapter 6.

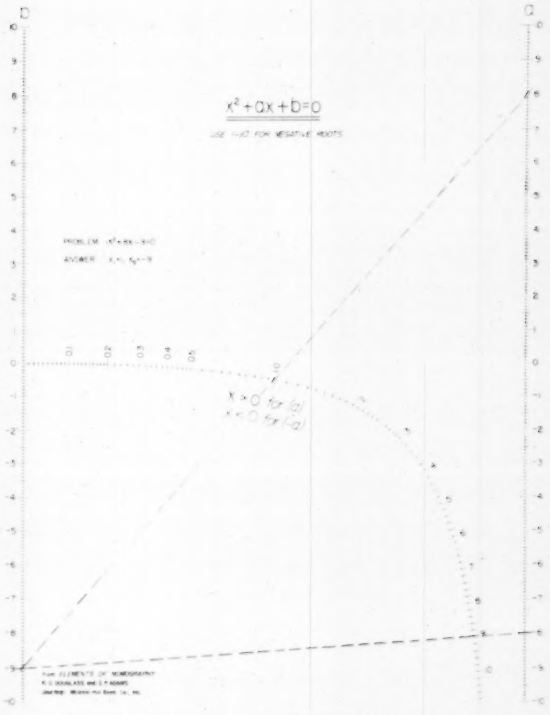


Fig. 4(*b*) A combination of the alignment diagrams of Figs. 1 and 3 made to permit inclusion of both $W+$ and $W-$ values

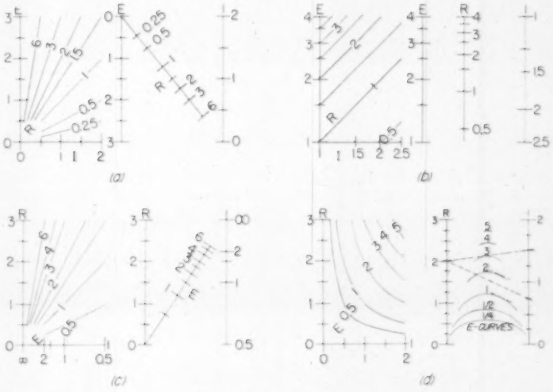

Fig. 6 The equation $E = IR$ can be put into various forms of network chart. Four of these have been shown and the corresponding alignment diagrams shown (not to scale) which result from them under the scanner process.

completely rectifies the $R$ curves. Otherwise the network chart appears as in (*d*), yielding a quasi-alignment diagram there.

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"Graphical Aids in Engineering Computations," by Hoelscher, Arnold, and Pierce, McGraw-Hill Book Company, Inc., New York, N. Y., 1952, chapters 3 and 5.

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# Polyurethane Rubber as a Material of Construction

*Higher stress capacity than natural rubber creates wide application possibilities for polyurethane*

**By G. H. Gates[1] and W. M. Larson[2]**

Goodyear Research Laboratory, Research Division,
Goodyear Tire & Rubber Company, Akron, Ohio

THE USE of polyurethane in industrial products is only beginning to be appreciated. In the rubber and plastics fields, polyurethane is classed as a rubber. In comparing some of the physical properties of polyurethane with natural rubber and GR-S, it will be found that polyurethane will have an elongation comparable to many pure-gum natural-rubber compounds together with a much higher stress capacity.

Fig. 1 shows a comparison of stress-strain tests on a pure-gum natural-rubber stock, a polyurethane-gum stock, and two black reinforced stocks, one natural rubber and one GR-S.

Fig. 2 shows a comparison of hardness of polyurethane to other polymers. It will be noted that the processible polyurethane is comparable in hardness to other rubbers whereas cast polyurethane, without loading, is much harder than the other polymers. In comparison to other rubbers, the outstanding property of polyurethane is in abrasion resistance. A comparison of polyurethane to an abrasion-resistant natural-rubber tread stock is shown in Fig. 3. In addition to tire treads, this property is being investigated in such fields as abrasion-resistant hose. In one particular case, hose with a polyurethane cover is presently on test in mines and quarries, where it is desirable to improve hose life by reducing the cover wear. Hose cores of polyurethane are being tested for transportation of sand and other abrasive materials.

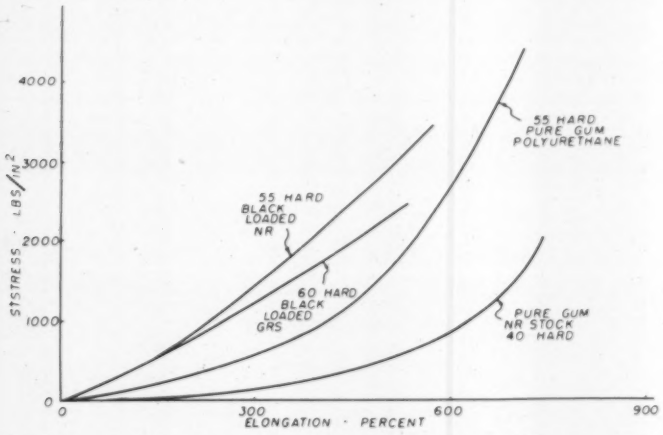


**Fig. 1 Stress-strain comparison of polyurethane versus NR versus GR-S**

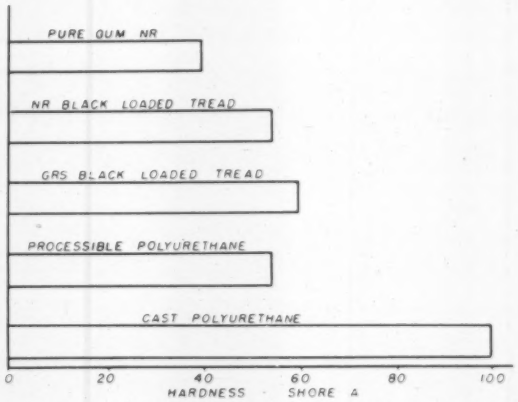


**Fig. 2 Hardness of polyurethane versus NR versus GR-S**

## Industrial Tires

In the factory where abrasion and/or metal adhesion is a problem with solid industrial tires, the polyurethane rubber is giving excellent performance. Rubber-to-

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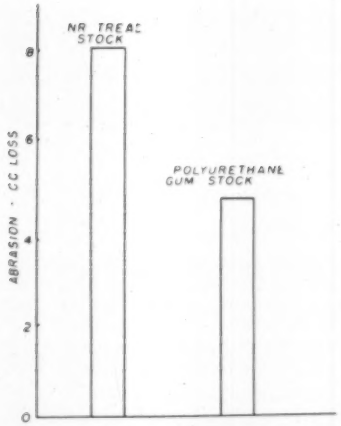


Fig. 3 Ring abrasion—cubic centimeters of gum lost during a 20-min abrasion period

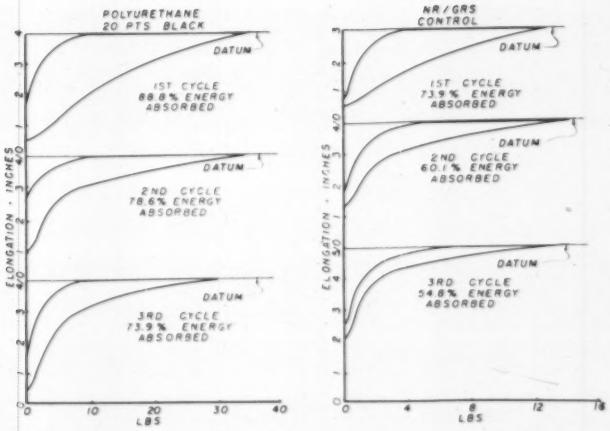


Fig. 4 Hysteresis loop instron—showing energy absorbed by polyurethane

Table 1 Motor-Mount Test Data

| | NR/GR-S control | Polyurethane no loading | Polyurethane 20 pts black |
|---|---|---|---|
| Hardness—Shore A | 53 | 60 | 70 |
| Compression set[a] | | | |
| Method B 77 F | 18.37 | 14.03 | 15.81 |
| 158 F | 25% max | 30.77 | 35.97 |
| Dyn. mod., kg/cm | 50.0 | 81.1 | 103.3 |
| Int. frict., kilopoises | 16.0 | 59.6 | 32.2 |
| Resilience, per cent | 46.8 | 41.6 | 45.5 |
| Hysteresis-loss instron energy absorbed, in lb-in. | | | |
| 1st cycle | 9.7 | 19.2 | 17.6 |
| 2nd cycle | 5.7 | Sample | 9.2 |
| 3rd cycle | 4.6 | Broke | 7.0 |

[a] ASTM-D 395-49T—method B.

iron adhesion systems are being used which approach 100 lb per in. Here the metal hub is degreased, shot-blasted, and two coats of isocyanate cement applied before application of the polyurethane rubber. Service life of 10 months (and still running) is reported on one of the latest test wheels. The wheels in question are the load-bearing wheels of electric trucks used throughout the factory for transporting materials and equipment. Ordinarily these wheels last a few weeks to a few months depending on the severity of usage. In this particular instance, several trucks had been modified to increase their load-carrying capacity.

Originally purchased to carry a single skid of stock, the "efficiency experts" had a second lift added above the original platform. Now two skids of stock could be carried in place of one. This doubled the load from 1600 to 3200 lb, but no provision was made for increasing the size or number of load-bearing wheels. A polyurethane solid-tire wheel was installed and has been in use continuously for the past 3 months with a minimum of chipping and cutting. Control tires are replaced every few weeks. Where the regular solid tires have a hardness of 81 Shore A, this particular polyurethane tire has a Shore A of 100.[3]

[3] Cast tire.

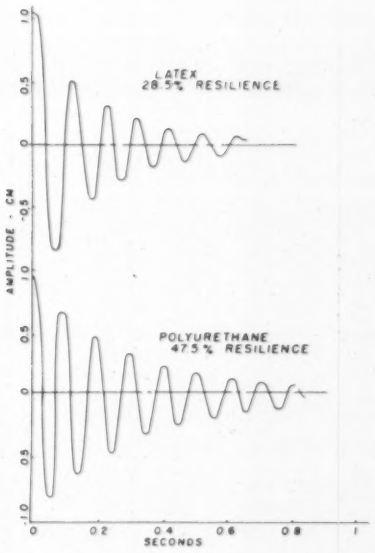


Fig. 5 Vibration-damping properties

Table 2 Properties of Cellular Elastomers

| | Latex foam | Polyurethane foam | Polyurethane expanded-type sponge |
|---|---|---|---|
| Density, pcf | 6.8 | 4.0 | 3.0 |
| RMA compression, lb | 30.0 | 45.0 | 180 |
| Flame resistance | Burns | Melts, resists burning | Burns slowly and melts |
| Tensile, psi | 33.2 | 25.0 | 88.0 |
| Elongation, per cent | 455 | 250 | 240 |
| Resilience, per cent | 28.5 | ... | 47.5 |

### High-Pressure-Pump Valve Inserts

Another recent development is the use of polyurethane valve inserts in high-pressure mud pumps used in oil-well drilling operations. These pumps force the drilling mud or slurry into the drilling system. The valve inserts of these pumps are subjected to high operating pressures and excessive abrasion during the drilling operation.

Over a period of time many types of materials have been tried and discarded as inserts. The most satisfactory commercial material proved to be an oil and heat-resistant neoprene compound. The first experimental polyurethane inserts of Vulcollan, which have just been removed, gave four times the service life of the regular material. This was a hard material, 100 Shore A. Further tests are continuing using a specially compounded polyurethane, but evaluation on the latest inserts has not been completed in the field tests.

### Motor Mounts

Of special interest is the recent investigation toward the use of polyurethane as a motor-mount material. What appears to be a relatively simple problem of anchoring machinery actually can become quite complex. Generally a motor mount is used to reduce vibration. Too hard a stock has no vibration-damping qualities—the motor might as well be fastened directly to the supporting medium. Conversely, too soft a stock can have good damping qualities but will deform like stepping on a piece of chewing gum. A good mount will damp the vibrations and harmonics over a wide range without deforming beyond the restricted limits of the equipment.

Data have been obtained which indicate that polyurethane should be a good motor-mounting material. Table 1 is a compilation of data comparing polyurethane to the natural rubber/GR-S motor-mount stock used in Cadillac automobiles. The higher heat rise and hysteresis loss in polyurethane are believed to be indicative of the ability of this material to absorb energy; namely, vibration energy. The higher dynamic modulus of the polyurethane is interpreted to mean that less stock will be necessary to achieve equivalent spring constant as compared to the control. Fig. 4 is included to show how much more energy is absorbed by polyurethane than by the regular mounting stock.

### Sponges and Foam

One of the better-known fields in which polyurethane is gaining importance is in sponges and foams. Table 2 has been prepared to compare some useful properties of latex, and open and closed-cell polyurethane foams. One of the outstanding properties of the polyurethane foams is its low density and high compressive strength as compared to latex foam. In comparison, the resilience of the polyurethane expanded foams looks promising with respect to vibration damping.

Fig. 5 is a comparison of the vibration-damping properties of a polyurethane-expanded sponge and general-purpose slab commonly called "Airfoam" or latex foam. It should be understood that the two materials differ both in polymer and structure. The latex foam has interconnected cells whereas the polyurethane sponge is an expanded material. Its structure is made up of an infinite number of closed gas cells which increase its resilience. It is believed that there is a need for a material which is firmer than regular Airfoam and less rigid than solid rubber. These data indicate that polyurethane sponge will help to fill the need.

These are only a few of the possibilities offered by polyurethane rubbers as a material of construction. Although much of this is in the laboratory stage, those articles placed in actual usage look most promising for the future of polyurethane.

*Acknowledgment.* The authors wish to acknowledge the following Goodyear Tire and Rubber Company persons whose work and records have contributed to this paper: H. A. Endres, T. H. Rogers.

## Linear Thermal Expansion of Teflon

As PART of its basic research program on the properties of materials, the National Bureau of Standards has determined the linear thermal expansion of annealed polytetrafluoroethylene (Teflon) from —190 to +300 C. This work also included a study of the effect of internal residual stresses on the expansion of Teflon and confirmed the presence of two first-order transitions at 20 and 30 C. With the data thus obtained, it is possible to calculate the dimensions that a Teflon product must have at room temperature in order that it will have the desired dimensions at the temperature of application.

Because the long Teflon molecules are not straight over their entire length, the structure of Teflon is not completely crystalline. Above 330 C Teflon is free of strain and has no crystalline structure. On cooling, Teflon starts to crystallize at about 325 C and becomes opaque and waxy in appearance. On further cooling first-order transitions occur at 30 and 20 C.

The Bureau studied the thermal expansion of four samples of annealed Teflon. The fused-quartz tube and dial indicator method was used on three of the samples. In this method the sample is placed upright in a fused-quartz tube, closed at the bottom. A movable fused-quartz rod rests on top of the sample and transmits the differential change in length of the sample and fused quartz to a dial indicator fastened to the top of the tube. The expansion of a fourth sample was measured with precision micrometric apparatus, which indicated that the small force exerted on the other samples by the quartz rod and dial indicator did not affect their expansion.

The coefficients of linear thermal expansion of annealed Teflon at zero and 50 C were found to be $114 \times 10^{-6}$ and $118 \times 10^{-6}$ C, respectively. The average coefficients of linear expansion from zero to 25 C and from 25 to 50 C were $200 \times 10^{-6}$ and $124 \times 10^{-6}$ C, respectively. The large differences between the "instantaneous" and average coefficients of expansion are caused by the transitions at 20 and 30 C. Repeated measurements indicate that the error of these coefficients is about $3 \times 10^{-6}$ C.

The investigation also demonstrated that residual stresses affect the length and thermal expansion of Teflon. When Teflon is stretched or elongated, internal tensile stresses are set up which decrease its expansion. When compressive stresses are present in Teflon, it is shorter and its expansion is increased. Annealing Teflon by heating to 350 C and cooling slowly removes the internal residual stresses.

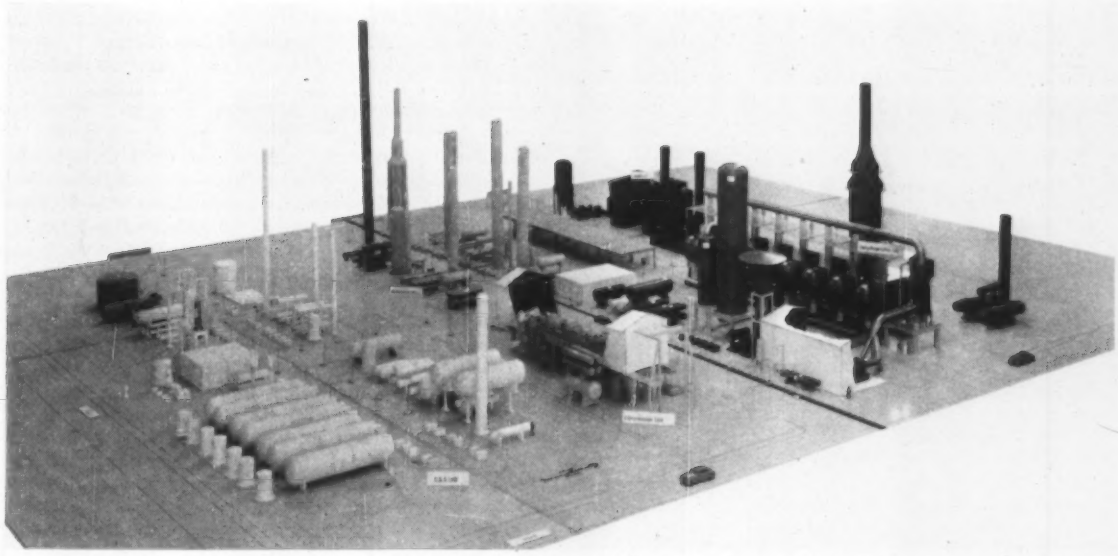

Fig. 1 Typical plant-layout model showing space requirements of pieces of equipment and general arrangement of the plant

# Models as a Design Tool

*Using models in the early stages of design can be of benefit in better communication and understanding, saving drafting expense, design training, field-operations planning, saving material, and building better plants*

**By Bruce L. Paton**

Design Supervisor, The Fluor Corporation Ltd.
Los Angeles, Calif.

Models have long been used in expressing design ideas. The shipbuilding industry has for centuries utilized models in the conceptive design of ships. For hundreds of years architects have utilized this medium, in fact to the point where many books on the subject of architecture devote a chapter to models, their uses, and advantages. Aviation, a comparatively new industry, soon discovered that models are of extreme importance in the design stage of engineering, and, of course, the construction industry has long used scale models.

In the past, most engineering-construction firms have used a model either as a check model, after design was complete and drawings of the job issued, or as an operator-training model to break in plant operators before the plant went "on stream." By using models in our design we have learned to consider them as a useful tool.

Practically every part of design is a three-dimensional problem. In spite of this obvious fact, it has been the accepted practice to express the solutions with two-dimensional drawings. Even very capable engineers and constructors lose time in the translating process. Reference to several drawings is usually required before the translation is complete. There is also the possibility that the thought will suffer and omissions will occur in the translation. It is not practical to include each and every detail in the several views or drawings required to convey an idea on paper. This is the reason why we, at Fluor, have adopted the visual design language common to every team member—scale models.

It has been the universal comment of our customers and their consultants that the designing of a job with the use of a model is a great timesaver for them. On a model, they are able to review in hours what previously would have required days. They have a much better feel of the job than they would have with nothing but drawings to work from. There is less misinterpretation of what Fluor is planning and, therefore, there are fewer changes in the later stages of design and after the plant is built.

A model is the only practical tool we know of which enables a person to get all of the key men concerned together at one time and expedite decisions and action. We were never able to get a fair-sized group of people to sit down together and go over a set of drawings.

Not only do Drafting and Engineering benefit from the use of a model; other groups are also vitally in-

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terested in them. Quite often, we have foreign consultants and customers who are not too well versed in the English language. Even with the help of interpreters, it has sometimes been difficult to get technical ideas exchanged. On many occasions, we have utilized our models very successfully to bridge a language barrier.

### Saving Drafting Expense

The only sure way of pinning down the value of a model is to use it in the design stage of a plant, and then compare costs against conventional drafting methods. We have done that, and we now know that we can justify the cost of models strictly on a design and drafting basis if they are used during the design stage of a job.

With the use of models we save both man-hours and calendar time in designing and constructing our plants. During the first full year that Fluor used design models on every major job undertaken, drafting costs were $100,000 less than the previous year, and gross business for that year was slightly more. Granted, there were improvements in our general drafting procedures to account for a portion of this saving but, during the year, we also issued, for the first time, individual isometric drawings of all screwed lines as a further construction aid to our field forces. When you consider the number of screwed lines in either a refinery or a petro-chemical plant, we feel this is quite an accomplishment.

### Design Training

Through the use of models, we make better use of our existing force of scarce highly trained people to develop, easily and quickly, our plants in model form. We then can rely on lesser-trained people to complete the detailing.

Models are a definite aid to construction people. Not only is it possible with a plant-layout model to have a much more definite idea of what their erection problems will be earlier in the job, but they are better able to offer suggestions to the designers that will lessen construction costs. They can more logically plan the sequence of erection. Everyone in the field from superintendent on down now has a very definite idea of what the plant will look like almost before any ground has been broken. No number of drawings could give this visual picture.

### Saving Material—Building Better Plants

A model layout lends itself to reducing material costs. Most of the saving will be in piping, although we have made savings in structures. It is easier to pick the best routing for pipes on a model than it is on drawings. A supervisor can at a glance pick up a misrouted line before the error can be compounded. We have found this saves pipe and fittings. At one stage in our model experimentation, we constructed a piping model of a complete refinery concurrently with piping-layout drawings. Doing the job in this manner, it was not too late to backtrack and change our drawings. On this job we eliminated $50,000 worth of pipe, fittings, and fabrication that would not have been noticed except by the closer observation gained through use of the model.

Piping laid out with the aid of a model is shorter and more direct. Fewer pipe elbows are used. Friction loss is reduced, sometimes allowing use of the next-smaller-size pipe or reduced pumping horsepower.

Access to manholes, hard-to-reach valves, instruments, and machinery can be much better visualized from a model than from drawings. As a result plants built using design models show considerably more planning for operators and maintenance.

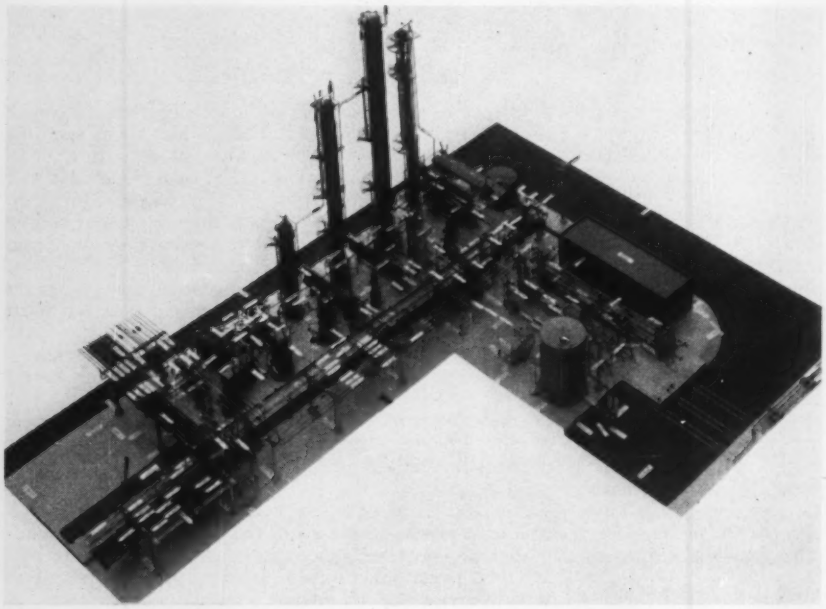

**Fig. 2 Typical piping-layout model which replaces old paper drawing method of laying out the piping system**

### Types of Models Used

The following three types of models are used for design at Fluor: (1) Plant-layout model, (2) piping-layout model, and (3) piping-arrangement model (full scale). Each of these types serves a specific and different purpose in our work.

*Plant-Layout Model.* Fig. 1 illustrates a typical plant-layout model. Notice its simplicity. With this model we are only interested in the space requirements of the pieces of equipment and the general arrangement of the plant.

The plant-layout model was developed to serve as a focal point, a clearinghouse for plant design, co-ordinating the activities of all our various specialists. In our design department, we have seven specialized groups: primary-plant layout, struc-

tural design, structural drafting, vessels, piping, instruments, and electrical drafting. On tight schedules, coordinating their efforts for maximum efficiency becomes a big problem. Designing our plants in model form first allows each of these groups to have a composite picture of the whole job sooner. They can, therefore, get an earlier start on their detailed construction drawings.

How then do we go about developing a plot plan through the use of a plant-layout model? First, the process engineers furnish process-flow sheets and equipment specifications to all concerned. Mechanical flow sheets are drawn. A rough sketch of the plot plan is drawn. The process units are indicated by blocks only. Equipment for the plant-layout model is made using preliminary outlines. The piping-layout designer then arranges the equipment to the best of his ability to suit the piping condition of the job.

Interferences may begin to show up at this point, or it may be necessary to change the over-all arrangement to secure a better plant. If this occurs, a fresh start is made. Here is where some of our measurable savings occur. It is easier and quicker to rearrange equipment on the model than on paper. Our plants have been more orderly and cleaner, from a design sense, since we initiated plant-layout models. It is considerably easier to build this orderliness into a model than it is on drawings. Possibly even more important is the fact that early approval of the layout on this model allows us to proceed to the next step in the design with less chance of change than we ever could with layout drawings.

Upon completion of this model a conference is held to approve the layout. A formal plot plan is then drawn of the approved arrangement shown on the model.

***Piping-Layout Model.*** Fig. 2 illustrates a typical piping-layout model. This is just one segment of a larger job, but you will notice this begins to get more complex. We have found that we can lay out a complete plant, including all piping, in approximately the same time as we could with the old paper drawing method.

The piping-layout designer starts the layout of the piping in the plant by first transposing the mechanical and utility flow sheets to the plot-plan drawing. This is to locate, generally, orifice runs, control valves, widths of pipe-ways and general space requirements. The paper work is kept to a minimum. Meanwhile, pieces of equipment are being made by model-shop personnel for the model. All equipment operating together as a process unit is painted the same color to allow easy identification. Model equipment is given to the layout designer, who indicates the location of manholes, nozzles, platforms, and ladders on vessels and returns them to the modelmaker. The modelmaker drills the nozzles, mounts platforms, ladders, manholes, etc.

The equipment is then mounted on plot boards. The piping-layout designer directs, either verbally or with sketches, the modelmaker in routing the piping on the model. This is done in a temporary manner using materials which have flexibility and allow changes to be made easily and quickly. All piping is shown with $^1/_{16}$-in-diameter brass rod, regardless of actual size. True OD of pipe is indicated with short lengths of rubber sleeving. Direction of flow, line number, specification, and insulation are indicated with plastic snap-on arrow-shaped line tags. These are placed on the lines as they are installed. Valves, orifice flanges, instrumentation, etc., are indicated by castings, which are slotted to fit on the brass rod. Fig. 3 shows a piping-layout designer verbally directing a modelmaker in the routing of a line.

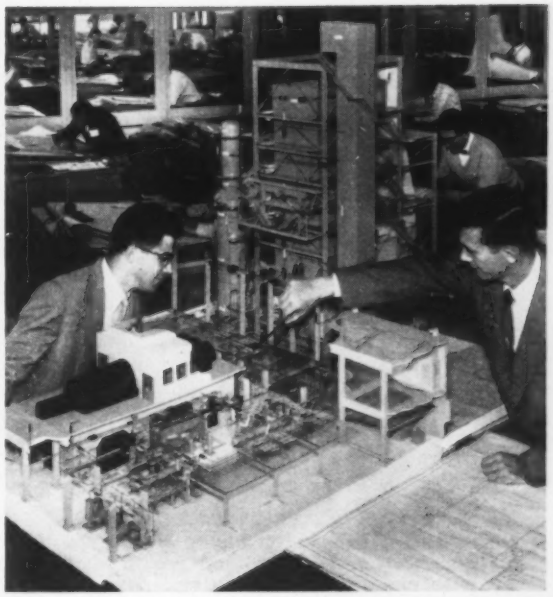

**Fig. 3 A piping-layout designer instructs a modelmaker in the routing of a line**

While the modelmaker is installing pipe, the designer is working out close fits on sketches for future use in making spools or arrangement drawings. He also is firming the location of working platforms, structures, etc., with the help and advice of the structural specialists.

During the period of installing pipe on the model, other design groups such as Electrical and Instruments are viewing the model and making sketches to locate their equipment. Racks for electric and instrumentation lines are installed on the model as the information is developed.

When the piping-layout model is complete, a formal job conference is held. Project, process, construction men, customer's representatives—all principals and key men concerned—are represented. Changes are agreed upon or approvals given.

A complete piping-layout model is shown in Fig. 4. This model, built to a scale of $^1/_4$ in. = 1 ft, is 11 ft wide × 24 ft long. It is made in 14 sections for reasons of accessibility and handling. The scale of our models is dependent upon over-all plant size. Most common scales are $^1/_4$ in. = 1 ft and $^3/_8$ in. = 1 ft. Occasionally we find it advisable to use a larger scale on congested sections.

Normal procedure at Fluor after obtaining approval of the piping-layout model is to start a minimum number of piping-arrangement drawings. These, together with spool drawings and the model or photos of the model, are used by construction to erect the piping. By having the model in the field, the number of piping-arrangement drawings required, especially sections and details, has been reduced.

***Piping-Arrangement Model.*** Fig. 5 shows a piping-arrangment model. Note that piping is shown in true diameter as opposed to the $^1/_{16}$-in. wire of the pip-

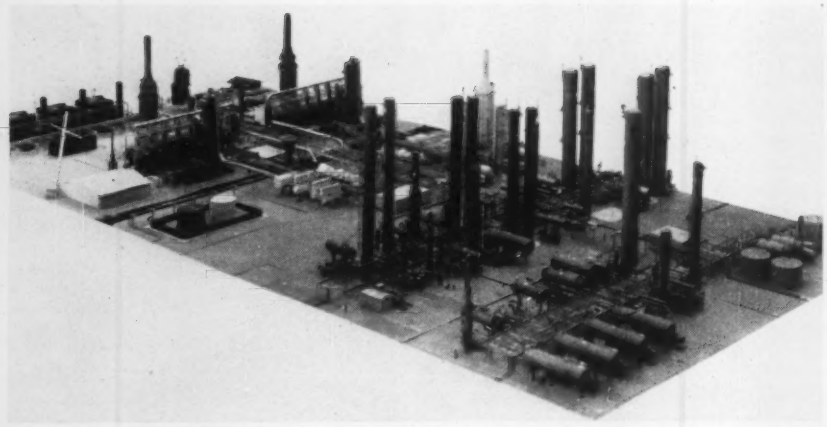

Fig. 4 Complete piping-layout model. Built to a scale of $^1/_4$ in. = 1 ft, model is 11 ft wide × 24 ft long.

ing-layout model. This model was made after the piping-layout model. True-diameter piping gives field personnel a better feel of piping-erection problems and, together with photoplans, can eliminate piping-arrangement drawings and serve as a basic check of the spool drawings.

The equipment for this model is made from approved vendors' drawings. As each pipe spool is drawn, it is fabricated in wire or plastic by the modelmakers and installed on the model. If the piece fits, the spool is basically correct as to orientation and its basic configuration. The spool drawings are then given a fractional dimensional check and issued for fabrication. We believe this method, when fully perfected, will utilize models to their greatest advantage.

Spools are normally drawn from formal piping-arrangement construction drawings. However, on one of our recent large jobs, we eliminated the usual piping-arrangement drawings and spooled directly from the piping-layout model. Photographs of the model with co-ordinates and basic dimensions added were substituted for the piping-arrangement drawings. The photographs are not ordinary ones but a type we have developed that can be duplicated on our ozalid machines. The plan type is usually blown up to scale $^1/_4$ in. = 1 ft.

We have bettered our estimated drafting time with this method, and our construction men indicate the idea will work well for them. We feel that future jobs may result in even greater savings, once our spoolers have gained the experience at spooling directly from a model and photographs rather than from dimensioned piping-arrangement drawings.

There is a question often asked: Are we contemplating eliminating completely our usual piping drawings? The answer at the moment is no. However, we do know that for the past two years Procter & Gamble, Cincinnati, Ohio, a company in an allied field, has almost completely eliminated piping-arrangement drawings. Instead they have substituted models and reproducible dimensioned photographs of the model.

There are many other drawings that will always be necessary to a job and cannot be eliminated by a model, such as foundation drawings, structural, electrical, instrumentation drawings, etc. In fact, when it comes right down to it, about all we hope to eliminate is a good percentage of piping drawings. Even if we don't eliminate a single formal drawing, we know that the drawings we do make are more accurate than they once were, and they are being done in less time.

### Estimate Structural Model

In addition to our pure design models, we frequently make what we call an estimate structural model to help determine and show potential customers just what we propose to give them. Fig. 6 shows a typical estimate structural model.

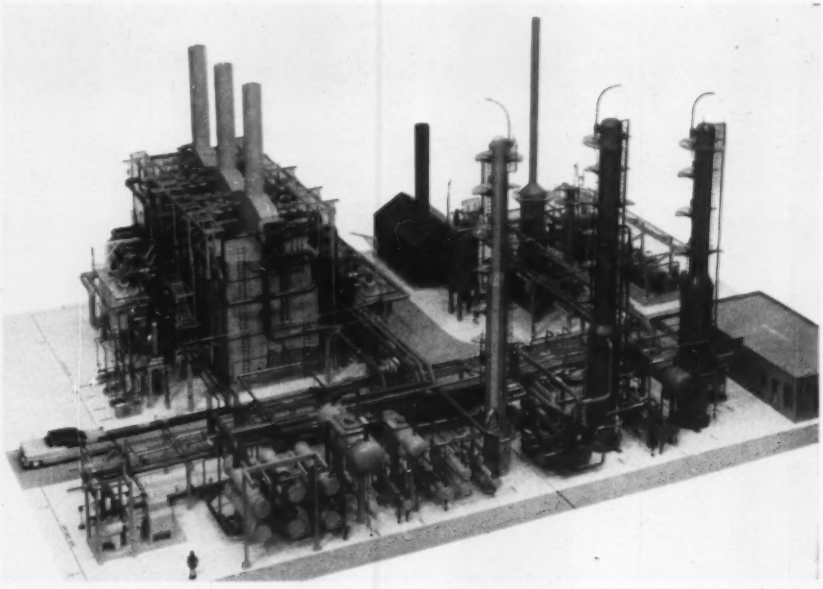

Fig. 5 Piping-arrangement model. By showing piping in true diameter, model reduces number of piping-arrangement drawings required.

During the preparation of a bid there is a very short time when sufficient information is available to build such a model. For this and other reasons it is mandatory to have the model shop located on the premises, such as ours is.

Since this model is constructed when job information is very meager, it must of necessity be simple and economical to build. However, it is a distinct aid in selling the job. Photographs of the model are included in our proposal book to the prospective customer, and on occasions the model itself is sent directly to the client when our bid is presented. Models also give investors tangible evidence of what their money is being spent on.

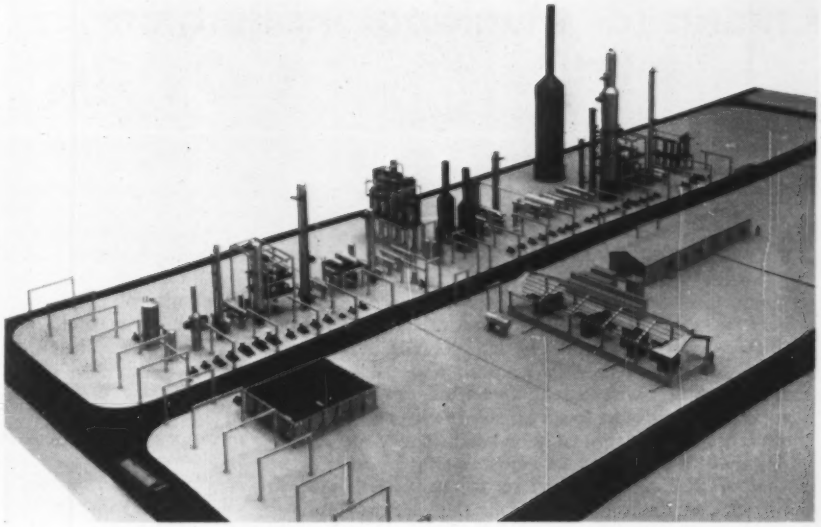

**Fig. 6 Typical estimate structural model which helps determine requirements of potential customers and show them what they may expect**

### Model-Shop Facilities

When Fluor started its model shop, there was no experienced help to call upon. It was necessary to use those within the organization who had the know-how of plant design, plus some manual dexterity, to delve into this new three-dimensional medium. A couple of unused drafting tables plus some carving knives made up the available equipment. After the first few attempts, it was discovered that to do the job properly professional modelmakers had to be obtained and certain necessary machinery purchased. We have gradually increased our facilities and manpower until we now have a 20-man crew of professional modelmakers. The shop contains close to $20,000 worth of equipment and stock. In addition to the crew of 20 modelmakers, we have at least as many plant designers who are capable of doing their own piping layout with pliers and soldering irons.

We having a building of 8000 sq ft of floor space designed specifically so that modelmakers and plant designers can work together. Drafting tables are within ten ft of the model assembly tables. Actually, during the past year, this space has not been nearly enough, and we have had to spill over into our other drafting rooms. We now have models throughout our drafting areas where they are as much a part of our drafting-room equipment as pencils and drafting machines.

### Disadvantages of Models

One of the drawbacks to models has been the fact that there is no simple way of duplicating them. Once a model has been made, there are usually demands that it be in several places at once. Through the efforts of Fluor personnel and a professional photographer, this disdavantage is being eliminated. To date, we have had quite fair results. In fact, our first somewhat crude attempts have not only satisfied our construction people, but have been applauded by them. The use of printable photographs, when fully developed, will, if nothing else, eliminate the drawing-in of background detail that is so time-consuming on standard-arrangement drawings.

Another disadvantage of models is that they are difficult to ship. However, with the use of transparent crates, air-freight transit with special handling at both points, this difficulty has been largely overcome.

### Summary

The use of models to the point where we can say they more than justify their costs has not happened overnight. As mentioned previously, we have been experimenting with them for over five years. The first two or three years were somewhat unproductive in so far as definitely pinning a dollar value on their worth. It has only been in the past year or so that we have been able to assign an approximate dollar mark to their savings.

The use of models in place of drawings runs contrary to too much tradition for the majority of draftsmen and plant designers.

We would strongly advise any company contemplating using models as a design tool not to try forcing the use of models upon their designers. We recommend that the first attempts at using this tool be assigned to the highest qualified designers available. Our experience has indicated that one of the strongest objections of a designer to models is that his design will be open to the view of any casual observer. Consequently, a top-notch man, who knows his design has no failings, will take to the use of models more readily than a less-experienced man will. After the first few jobs, the converting of less-experienced designers becomes a simpler chore.

We feel that the many advantages we have achieved through the use of design models are just a beginning. Certain disadvantages of the model technique are acknowledged, and methods of overcoming these disadvantages are being devised. No one is making any drastic statements about the elimination of the drawings altogether. But we are predicting greater savings, improved communication, and better designs through continued and expanded use of design models.

# Criteria for Municipal Incinerators . . .

## . . . The Designer's View

**By Samuel A. Greeley**

Partner, Greeley and Hansen, Engineers, Chicago, Ill.

**From 50 years of practice in refuse-disposal projects, the author concludes that the design of municipal incinerators is as difficult as any problem encountered in sanitary and municipal engineering. The background of design criteria is considered to mean the local conditions on which the design may be established, such as the quality and kind of refuse, surface and subsurface conditions of the site, adjacent roadways, climate, environment affecting the chimney and its discharge, type of building, and so on. These and other items are considered in the paper.**

THE AUTHOR considers the background of design criteria for municipal incinerators to mean the local conditions for which the bases of design are to be established. These include such matters as the quantity and kind of refuse for which capacity is to be provided, the surface and subsurface conditions at the site, the adjacent roadways, the climate as affecting the extent of enclosure, the environment as affecting the chimney and its discharges, and the type of building suited to the locality.

The scope of design criteria extends to those things which affect the efficiency of operation, such as the bases of design of the facilities pertaining to combustion, and the factors which affect the operation of the furnaces, such as clearances, fly-ash-removal facilities, and control instruments. The design criteria of the general parts of a municipal incinerator will not be discussed at any length.

### Parts of a Municipal Incinerator

Of a complete municipal incinerator, about 40 per cent of the cost is for the furnaces and their appurtenances, and about 60 per cent for the approaches, storage bin, building, and chimney. The major parts are listed in Table 1.

*Kinds of Furnaces.* In municipal incinerators, there are many kinds of furnaces, some of which are round and others rectangular in plan, and there are numerous departures, such as revolving cylinders and vertical or high furnace structures. Most of these different kinds have been developed and promoted by manufacturing concerns and this accounts for the very considerable variety. Five different kinds were drawn up by the author's firm in 1950 as part of the contract documents for receiving competitive bids for a rubbish incinerator for the city of Los Angeles. Each furnace was specified to have a rated capacity of 100 tons of rubbish per 24 hr. These are briefly described as follows:

1 Rectangular furnaces stoked manually or by oscillating or moving grates.
2 Round furnaces mechanically stoked.
3 Furnaces with traveling grates.
4 Furnaces with moving grates made of pallets or plates.
5 Furnaces having grates or kilns.

Fig. 1 is the rubbish incinerator at St. Louis, Mo., having a rated capacity of 400 tons per 24 hr.

There are, of course, other kinds, such as rectangular furnaces with Flynn and Emrich grates and more recent designs of furnaces with moving grates.

Table 1 Principal Components of a Municipal Incinerator and Costs

| Item | Illustrative unit cost per ton of rated capacity |
|---|---|
| 1 Scales, scale house, entrances and exits, maneuvering yard, dumping rail, and enclosing wall | $ 100.00 |
| 2 Storage bin | 200.00 |
| 3 Cranes | 225.00 |
| 4 Outside flues and fly-ash-removal facilities | 400.00 |
| 5 Chimneys | 300.00 |
| 6 Miscellaneous items, such as drains, piling, and woodhogs | 75.00 |
| 7 Furnaces | 1200.00 |
| 8 Inside flues | 85.00 |
| 9 Building and enclosures | 1415.00 |
| Total | $4000.00 |

### The Designer

There are three kinds of designers active in refuse-incineration practice as follows:

(*a*) The designer in a public-works office—the public designer. This kind is well illustrated by those in New York City who have designed completely several very large incinerators.

(*b*) The designer in private practice—a private practicing engineer. The author is this kind of designer, his firm having prepared plans and specifications for a considerable number of refuse incinerators.

(*c*) The designer associated with a manufacturing company—a proprietary designer. Generally this kind designs only the furnace and its appurtenances which the manufacturer promotes, sometimes, under a patent or alleged patent. Many refuse incinerators have been acquired by municipalities under designs of this kind.

It should be noted that sometimes the complete design is prepared by the public or private designer and the proprietary designer jointly. The latter designs the furnace and its appurtenances to fit the building and the chimney designed by the others in accordance with de-

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tailed specifications, design limitations, and guarantees. Sometimes a contract for the furnaces and their appurtenances is let first and the building and its appurtenant facilities are then designed to fit the furnaces to be furnished under the separate contract.

### Definitions

"Refuse" is the general term for the solid materials wasted by a community. It includes "garbage" (waste from the handling, preparation, and consumption of food), and "rubbish." Rubbish is further divided into "combustible rubbish" (materials like paper, wood, rags, brush, and tree trimmings), and "noncombustible rubbish" (metals, glass, and the like). Such noncombustible rubbish as is delivered to an incinerating plant is removed from the furnaces as "ash" or "residue."

The terms "fly ash" and "particulate matter" are used interchangeably to designate the finely divided solid particles in the gases leaving an incinerator furnace. Such particles vary widely in size, but roughly may be divided into those which are large enough to be deposited on the ground after discharge from a chimney, and the smaller particles which remain in suspension indefinitely.

The term "raw gas" is used to designate the gaseous products of combustion as they leave the combustion chamber of the incinerator furnace, with their load of particulate matter. After these have passed through structures or equipment designed to remove the particles of fly ash, we use the designation "treated gas."

Particular definitions of refuse materials on the basis of laboratory analyses are rather limited in number. A relatively dry refuse might contain 20 per cent of moisture, 20 per cent of ash, and 60 per cent of combustible matter. The combustible matter might contain the materials given in Table 2.

Table 2 Combustible Material

| Material | Pound per pound of combustible |
|---|---|
| Carbon | 0.50 |
| Hydrogen | 0.06 |
| Oxygen | 0.40 |
| Nitrogen | 0.03 |
| Sulphur | 0.01 |
| Total | 1.00 |

A refuse of the characteristics given in Table 2 would require theoretically 3.68 lb of air per lb of refuse for combustion. The gaseous products of combustion (exclusive of the ash) would amount to 6.32 lb of air per lb of refuse, with 50 per cent of excess air.

### Principal Parts of a Design

The design of an incinerator comprises the following four principal parts:

(*a*) General aspects such as the quantity and character of refuse, the location of the plant, and the characteristics of the receiving airway. It is assumed that such general parts will have been covered by an adequate engineering investigation and report.

(*b*) General arrangements, such as the approaches, the yard, the scales, the storage bin, the building, the clearances within the building, the cranes, and the ash-removal facilities.

Fig. 1 Incinerator with a rated capacity of 400 tons per 24 hr

(*c*) The part which comprises the furnaces and their appurtenances with bases of design for grate areas, volumes, dampers, flues, and of subsidence (or expansion) chambers, for the removal of fly ash or particulate matter. This part constitutes the structures and the equipment which have to do with combustion.

(*d*) The chimney.

As stated in Table 1, the building proper may cost about $1415.00 per ton of rated capacity and, including scales, yard, storage bin, cranes, and miscellaneous items, as much as $2,000.00 per ton. Adequate housing amounts to about 1500 cu ft per ton of rated capacity, but often the volume exceeds 2000 cu ft, depending upon other services included, such as garage and shop spaces. The cost of the building and appurtenances will sometimes exceed 60 per cent of the total cost.

### Bases of Design of Furnaces and Appurtenances

The first matter of importance in determining bases of design is the kind of refuse to be incinerated. As between mixed refuse (garbage and combustible rubbish) and rubbish, there are important differences, in particular as to the products of combustion and the amount of air required. These are illustrated in Table 3.

Table 3 Differences Between Types of Refuse

| Item | Kind of refuse: Rubbish | Mixed[a] |
|---|---|---|
| Per cent moisture | 15 | 54 |
| Pounds of air per pound of refuse for: | | |
| Combustion plus 50 per cent excess | 5.85 | 3.18 |
| Cooling to 1600 F | 4.04 | 0 |
| Total | 9.89 | 3.18 |
| Gaseous products of combustion in cubic feet per pound of refuse at 1600 F | 554 | 211 |

[a] 65 per cent garbage at 75 per cent moisture and 35 per cent rubbish at 15 per cent moisture.

Obviously, the characteristics of the refuse affect most of the bases of design, but, because of the great variation in these characteristics, safe margins for limiting conditions are necessary.

Table 4 Background of Design-Criteria Sizes of Furnaces and Appurtenances

| Plant | Kind of refuse | Rate of burning in lb per sq ft per hr | Volume in cubic feet per ton of rated capacity | | | | Furnace inside depth or diameter, ft |
|---|---|---|---|---|---|---|---|
| | | | Furnace | Combustion chamber | Subsidence chamber | Total | |
| New York City: | | | | | | | |
| Betts Avenue | M | 69.5 | 25.0 | 15.7 | 40.0 | 80.7 | 8.0 |
| Gansevoort | M | 64.0 | 16.0 | 28.0 | 40.0 | 84.0 | 8.0 |
| Washington—No. 3 | R | 51.0 | 14.3 | 29.0 | 204.0 | 247.3 | 8.5 |
| Baltimore | M | 57.5 | 11.1 | 16.5 | 11.0 | 38.6 | 8.75 |
| Brookline | M | 98.5 | 9.1 | 25.7 | 11.4 | 46.2 | |
| Cincinnati—No. 3 | M | 108.6 | 7.24 | 20.0 | 93.6 | 120.8 | 11.08[a] |
| Milwaukee: | | | | | | | |
| Green Bay | M | 84.2 | 12.3 | 18.3 | 10.5 | 41.1 | 11.75[a] |
| South Side | M | 56.8 | 12.4 | 16.4 | 37.3 | 68.1 | 11.00 |
| Winnipeg | M | 78.0 | 9.0 | 16.0 | 18.8 | 43.8 | 11.72[a] |
| St. Louis: | | | | | | | |
| South Side | R | 50.0 | 14.5 | 31.8 | 57.0 | 103.0 | 7.5 |
| Evanston | M | 53.5 | 13.6 | 28.3 | 53.0 | 95.0 | 10.0 |

[a] Diameter of round furnace.
NOTES: Volumes are exclusive of flues.

The second matter to consider comprises the capacity, the size, and the shape of the furnace. The principal bases of design are discussed in the following paragraphs. The bases given are applicable to the combustion of mixed refuse and to an environment in which air pollution is not deemed to be highly critical.

*Size.* Refuse-incinerator furnaces have been built with rated capacities of 250 tons per 24 hr as in New York City, using moving grates. A more usual range is 100 to 150 tons.

*Burning Rate.* Until recently a considerable number of refuse incinerators have been designed to operate at burning rates in excess of 70 lb per sq ft of horizontal grate area per hr. These high rates of burning are considered to increase the quantity of particulate matter and other air pollutants. Lower burning rates are now considered to contribute to the control of the pollution of the receiving airways. A recent design for Evanston, Ill., has a burning rate of 53.5 lb per sq ft per hr for mixed garbage and rubbish.

*Depth of Furnace.* Distances from the inside front wall to the rear wall or the diameter of a number of existing incinerators are given in Table 4. To facilitate stoking, an inside depth of not over about 10 ft is indicated.

*Volumes.* Table 4 shows the unit volume in cubic feet per ton of rated capacity of furnaces, combustion chambers, and subsidence chambers for a number of plants. They will depend considerably upon the characteristics of the refuse and should be larger for rubbish than for mixed refuse. For mixed refuse a furnace volume of 12.5 and for rubbish of 20.0 cu ft per ton seems to be reasonable.

To meet air-pollution requirements, combustion and subsidence chambers, particularly the latter, have been increased greatly in unit volume of recent years. A volume in these two structures of around 80 cu ft per ton is indicated.

*Flues.* The area of flues is usually determined on the basis of limiting velocities in feet per second. For the flue between the furnace and the combustion chamber, a relatively high velocity of 35 fps or more is indicated to provide mixing and of other flues of 25 fps.

### Degree of Air-Pollution Control

A considerable number of municipal ordinances are in effect relative to this matter and most of them have taken either one or the other of the following forms:

(*a*) The weight of particulate matter per 1000 lb of gas with 50 per cent excess air; the usual limiting value being 0.85 lb as established in the ASME model code.

(*b*) The weight of particulate matter per cubic foot of gas at standard conditions. The standard set up by the Los Angeles County Air Pollution Control District is 0.40 grain per cu ft of gas at 60 F, 14.7 psia, and 12 per cent $CO_2$.

None of the ordinances so far has undertaken to specify the amounts of other substances in the gaseous products of combustion which may be tolerable in regard to air pollution, such as the oxides of nitrogen and sulphur. The two standards to which reference is made permit the amounts of particulate matter in chimney discharges given in Table 5.

Table 5 Particulate Matter in Chimney Discharges

| Per cent moisture in refuse | Pounds of Fly Ash Permitted per Ton of Refuse | | | |
|---|---|---|---|---|
| | Wet refuse (At 0.85 lb per 1000 lb of gas) | Dry solids (At 0.85 lb per 1000 lb of gas) | Wet refuse (At 0.40 grain per cu ft) | Dry solids (At 0.40 grain per cu ft) |
| 20 | 10.7 | 13.4 | 8.9 | 11.1 |
| 30 | 9.6 | 13.7 | 7.8 | 11.1 |
| 50 | 7.4 | 14.7 | 5.6 | 11.2 |

A rational or realistic yardstick for regulating the discharge from incinerator chimneys is much to be desired. Such a yardstick might limit the content of particulate matter in the gases entering the airway to a certain number of pounds per ton of refuse burned. Present available experience suggests a limit of 10 lb per ton, but many more data are needed before a final determination. Yardsticks for other pollutants such as nitrogen and sulphur may be needed in some locations.

While little is known regarding the quantity of particulate matter in the raw gases, the amount is illustrated by the units of 15 lb per ton of mixed refuse and 20 lb per ton of rubbish. On this assumption, equipment to remove fly ash or particulate matter should have an efficiency based on the raw gases of upward of 50 per cent. To permit the establishment of more accurate and realistic bases of design, the author considers that full-scale tests are desirable to determine the efficiency of existing fly-ash facilities of different kinds.

### Air-Pollution-Control Facilities

Many bases of design of municipal refuse incinerators are now scrutinized in the light of their effect on the reduction of the pollution of the receiving air. On this account, three general factors are important:

(*a*) A reduction in the quantity of under-fire air.
(*b*) An avoidance of too frequent disturbance of the fire by charging refuse onto the grate.
(*c*) A lower burning rate.

Specific yardsticks or procedures in relation to the foregoing are not, as yet, fully developed.

In a study of air-pollution-control facilities, three very general characteristics should be kept in mind, as follows:

(*d*) Facilities which can be used with hot gases of combustion.
(*e*) Facilities requiring cooled gases of combustion.
(*f*) Facilities using water.

Various devices for removing particulate matter from the gaseous products of combustion are illustrated as follows:

(*g*) Subsidence chambers with various kinds of trapping and impingement walls and corners. This device is applicable to hot gases and is extensively used.
(*h*) Subsidence chambers with water sprays and a bath as installed at Milwaukee, Miami, Philadelphia, and, without a water bath, at a number of rubbish incinerators in the Los Angeles area.
(*i*) Cyclone or centrifugal precipitators made in different forms by a number of manufacturers. All require the gases to be cooled to about 700 F. Few have been installed in refuse incinerators.
(*j*) Bag filters made of steel or glass mesh. These require the gases to be cooled. In so far as the author knows, none has been installed in refuse incinerators.
(*k*) Electrostatic precipitators which are used in power plants on gases cooled by passing through a boiler. In so far as the author knows, none has been installed in refuse incinerators.
(*l*) The municipal refuse incinerator at Framingham, Mass., is equipped with a scrubber for the gaseous products of combustion.

There is not enough precise operating information to permit a classification of the foregoing as to efficiency and other qualities. Having in mind the present very much limited data as to what might be accomplished by these various devices for removing fly ash from refuse-incinerator gases, it is easier to suggest what not to do than to arrive at a selection for a particular local condition. Considering that public money should be spent only for "sure things," any device other than subsidence coupled with baffling, trapping, and impingement, cannot generally be recommended.

### Draft Facilities

The air needed for combustion is provided by forced draft, by induced draft, or by natural draft. The first two require fans and the third a chimney of adequate height and cross-sectional area. With induced draft, the chimney can be relatively small. With natural draft, it should be large enough to draw the gaseous products of combustion through the grate and away from the furnace chamber. With forced draft, the suction need only operate from over the grate. Dampers are required to control the natural draft.

Forced draft with an adequate chimney is a satisfactory design procedure. For many environments, a chimney 150 to 175 ft high is adequate. It should have an area at the top of about 0.25 sq ft per ton of rated capacity.

Fig. 2 Municipal incinerator building at Alexandria, Va.

### Architectural Treatment

The building enclosing the furnaces and their appurtenances should be adequate and pleasing. There seems to be no need for an ornate structure. Much can be accomplished by attention to proportion and other architectural fundamentals. In some cases, the environment suggests special architectural treatment, as at Alexandria, Va. (see Fig. 2).

### Looking to the Future

In the opinion of the author, the present time may be characterized as one of transition. The design of municipal refuse incinerators is being considerably affected by the great interest on the part of the public and its representatives in clean air and by the changing habits of people as regards the purchase and use of packaged goods, the increased practice of wrapping garbage, the greater use of garbage grinders, and the consequent change in the characteristics of refuse. It is suggested that there is not enough information to permit a realistic appraisal of the extent and kind of facilities for the treatment of the raw gases of combustion. For these facilities, realistic bases of design and expenditures cannot be stated at this time.

The new characteristics of the refuse appear to have become somewhat stable, although an increase in the grinding of garbage may occur.

Looking to the future, it is most desirable that all aspects of the air-pollution problem should be explored fully including field test and operating records.

# Infrared Analysis

*Operating principles of continuous infrared analyzers, and typical applications to air-pollution and industrial process control*

**By Nelson W. Hartz**

Instrument Line Manager,
Mine Safety Appliances Company, Pittsburgh, Pa.

SINCE approximately 1945, infrared spectroscopy has become an accepted and respected technique widely used in gas, petroleum, and chemical engineering. It is being used for both qualitative and quantitative analyses, making such determinations automatically with tremendously greater speed and precision than were ever attainable by the classical laboratory methods. In addition, it is adaptable to continuous-process analysis and control.

It has been found experimentally that dissimilar compounds absorb in widely different spectral regions. For instance, carbon monoxide, water vapor, ammonia, methane, and sulphur dioxide differ greatly in their absorption patterns. On the other hand, similar compounds have similar spectra. The absorption of ethane, propane, and butane is quite similar although there are regions of absorption difference. Fortunately, these differences are sufficiently marked so that it is possible to determine a small percentage of one of these gases in the presence of a much higher concentration of the other two.

### Types of Infrared Analyzer

Two classes of infrared analyzers have been developed for the investigation and application of infrared radiation. The first of these, the spectrometer, was developed originally as an aid in the discovery of facts about infrared radiation.

A spectrometer in its simplest form consists of an infrared light source, a sample cell, a light-dispersing system, and an infrared detector.

The absorption of the sample material is determined at each wave length or frequency of infrared light. From these data sample transmission can be plotted as a function of wave length. Modern spectrometers automatically plot the spectra of a sample in less than 15 minutes. From the absorption spectra of a mixture, the spectroscopist can calculate the composition of the mixture.

The nondispersion instrument is the second type of infrared analyzer. Fundamentally it consists of an infrared source, a sample and filter cell, and an infrared detector. Since the light is not dispersed, the analyzer makes a simple measurement of the absorption by the sample in those spectral regions which normally reach the detector and cause an output signal.

Experience has shown that the spectrometer and the nondispersion analyzers are complementary. Each has its place. The spectrometer is ideally suited to laboratory and pilot-plant use where it is necessary to analyze many different types of mixtures for many different compounds. The nondispersion instruments are primarily used for industrial process control where an analysis for one component of a mixture is desired.

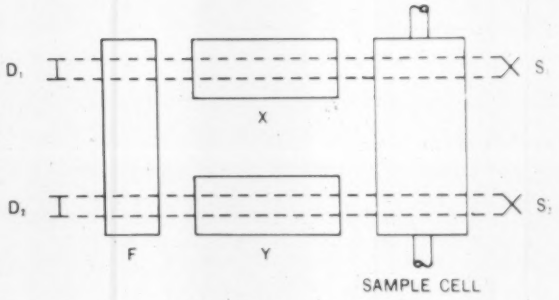



Fig. 1 Schematic sketch of nonselective-detector instrument

### Nondispersion Analyzers

The nondispersion analyzers are classed in two categories. These are the selective and the nonselective detector types.

*Nonselective Detector.* A schematic diagram of a nonselective-detector instrument as originally proposed by Schmick is illustrated in Fig. 1. In this system, light from two sources, $S_1$ and $S_2$, is directed to two detectors, $D_1$ and $D_2$, which are usually bolometers or thermopiles. The detectors are electrically connected in opposition so that they measure the difference in light intensity between the two beams.

Assume cells X, Y, and F are filled with nonabsorbing gases. When an absorbing gas enters the sample cell through which both beams pass, the gas reduces the radiation in each beam by a similar amount. As a result, no difference between the beams is produced and the detectors have no output.

In order to sensitize the nonselective detector system the following method is usually employed: Assume a hypothetical mixture to be analyzed consisting of absorbing gases A and B and a nonabsorbing gas. Cell X is filled with A, the gas to be detected. Cell Y is filled with a nonabsorbing gas.

The gas A in the sample cell, passing through both beams, will affect the Y-beam more than it affects the X-beam because the A-gas in X already has removed most of the spectral regions at which A absorbs. Thus

Based on a paper contributed by the Process Industries Division and presented at the Semi-Annual Meeting, Cleveland, Ohio, June 17–21, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

the beams will be unbalanced and an output signal will be generated by the two detectors. When the analyzer is calibrated in this manner it also will be sensitive to gases which have overlapping bands with A.

If B has bands that overlap A, gas B will be placed in the filter cell F so that it removes most of the energy in the bands absorbed by B. This reduces the sensitivity of the analyzer to B, and hence increases the selectivity of the analyzer to A.

In some cases the techniques mentioned in the previous paragraphs are not sufficient to obtain the desired selectivity. During the past 10 years, several independent investigators have developed a method for obtaining higher selectivity. This method requires that cell Y, instead of being filled with a nonabsorbing gas, be filled with a mixture of B and a nonabsorber.

The concentration of B is adjusted so that when B is placed in the sample cell it affects the two beams equally and this produces no output signal. When A is introduced into the sample cell, it will affect the Y-beam more than it affects the X-beam and will cause an output. Since the sensitivity to B is virtually zero and there is still sensitivity to A, the selectivity of the analyzer has been increased greatly.

***Selective Detector.*** The second type of nondispersion analyzer is the selective-detector instrument. A schematic diagram of this type of analyzer as developed by Luft is illustrated in Fig. 2. The light from two sources $S_1$ and $S_2$ is directed into two detector chambers $D_1$ and $D_2$. The selective differs from the nonselective instrument in the type of detector used.

The normal type of selective detector is a volume infrared-absorbing gas. When radiation is absorbed by the gas, the temperature and pressure of the gas increase. This pressure increase is generally measured with a condenser microphone.

In the Luft analyzer the two detectors $D_1$ and $D_2$ are separated by a membrane so the only time the membrane is deflected is when one beam is stronger than the other. In this way the output of the condenser microphone is a measure of the difference in intensity between the two beams.

With the same hypothetical problem involving the absorbing gases A and B and a nonabsorbing gas, the selective-detector instrument would be sensitized in the following manner: Gas would be placed in the detector chambers $D_1$ and $D_2$. When gas A is passed through the sample cell, it reduces the intensity of the sample beam. This produces an output signal.

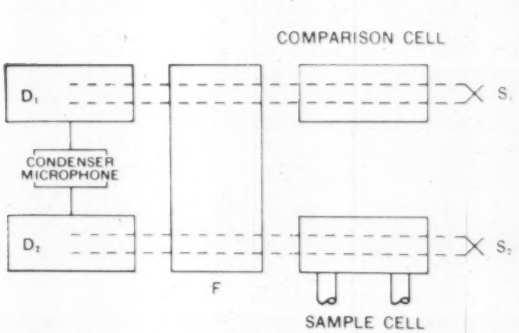



**Fig. 2 Schematic sketch showing selective-detector instrument**

Since the detector is filled with A, it is sensitive only in those spectral regions absorbed by A. Thus only gases which have overlapping bands will affect the measurement. If B has interfering bands, it is placed in cell F so that the wave lengths absorbed by it are removed before the light enters the detector.

***Interrupted Radiation.*** Present selective-type analyzers are typified by the use of interrupted radiation. In such analyzers the two beams are alternately blocked and then passed, and the amplifier is tuned so that only signals varying at the frequency of interruption are amplified. Since the amplifier responds only to the interrupting frequency, ambient-temperature gradients do not cause errors because the change in gradient is much slower than the interrupting frequency.

## Operation of Analyzer

A typical selective analyzer is shown schematically in Fig. 3. Two similar nichrome filaments are used as sources of infrared radiation. Beams from these filaments travel through parallel stainless-steel cells. One beam traverses the sample cell and the other the comparison cell. The emergent radiation is converged into the single detector cell by a beam combiner which consists of two cylinders in the form of a V.

As the gas in the detector absorbs radiation, its temperature and pressure increase. An expansion of the detector gas causes a condenser-microphone membrane to move. This movement, when converted and electrically amplified, produces an output signal.

Between the source and the cells, a rotating or reciprocating shutter alternately blocks the radiation to the sample cell and the comparison cell. When the beams are equal, an equal amount of radiation enters the detector from each beam. The amplifier is tuned so that the only variations in light intensity occurring at the alternating frequency produce an output signal. Therefore the beams are equal and the output is zero.

When the gas to be analyzed is introduced into the sample cell, it absorbs and thus reduces the radiation reaching the detector from the sample beam. As a result the beams become unequal and the radiation entering the detector flickers as the beams are alternated. The detector gas expands and contracts in accordance with the flicker. In this way, the detector directly indicates the difference between the two beams.

The expansion and contraction of the gas cause the membrane to move in response. The membrane movement varies the condenser-microphone capacity. The variation in capacity generates an electric signal which is proportional to the difference between the two radiation beams.

Next, the electric signal is amplified by a conventional a-c amplifier and then conducted to a synchronous rectifier. The synchronous rectifier generates a d-c signal, the polarity of which depends upon which of the two beams is stronger. This d-c signal, which is due to an increase in sample absorption, causes an electronic recorder to drive upscale. As the recorder drives upscale, it causes a reduction in the voltage applied to the comparison-beam source.

The recorder continues to drive upscale until the beams are returned to balance. The position of the recorder indicator is then a measure of the absorption of the sample and hence the concentration of the analysis com-

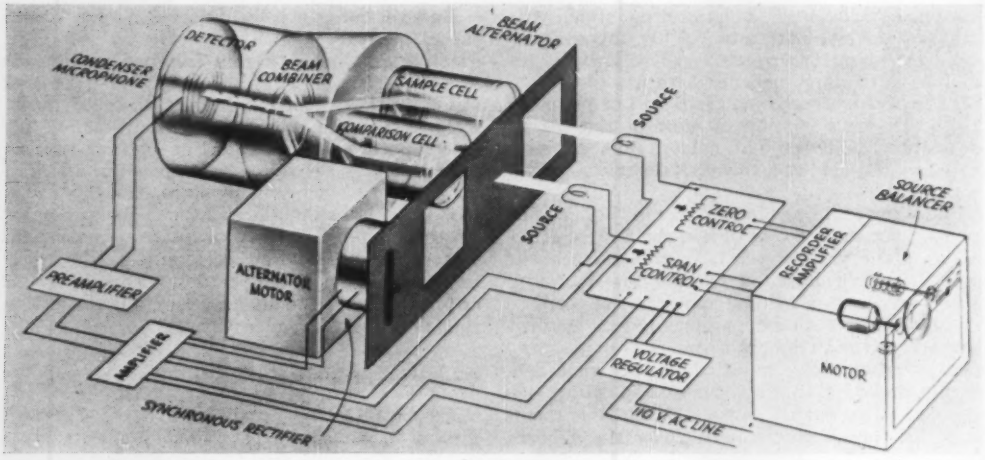



**Fig. 3 Detailed drawing of null-balance, selective-detector instrument. Two similar nichrome filaments are used as sources of infrared radiation.**

ponent. Thus the recorder automatically and continuously provides a record of the composition of the sample mixture.

From these descriptions it is obvious that the nonselective-type instrument is a less complex assembly than the selective type; however, in many instances the additional components of the selective analyzer are required to achieve the sensitivity or the selectivity that is necessary to handle a specific problem of analysis.

## In Practice

Because our original interest in gas detection and measurement was related to the detection of trace concentrations of contaminants in air, from the standpoint of industrial hygiene and air-pollution control, we were quickly convinced that the selective-detector type of infrared analyzer would most readily lend itself to the solution of such problems. After approximately 10 years of experience this original estimate has been thoroughly proved. As an example, we have been able to provide a quantity of such instruments for measurement of carbon monoxide in the atmosphere in and around Los Angeles that were sensitized for a full scale range of 0 to 20 parts per million in air without any measurable cross sensitivity to atmospheric moisture or carbon dioxide.

A relatively large number of similar but less sensitive instruments are being used by the American Gas Association Laboratories and numerous appliance manufacturers to measure CO in the combustion products from gas appliances to determine whether they are within the limits established by the A. G. A. In addition those same users are utilizing similar types of instruments to accurately measure carbon dioxide in their flue gases.

Other users are applying such instruments for measuring sulphur dioxide in stack gases and in the air in the vicinity of industrial plants as a part of their air-pollution programs. In the first instance the instruments may be sensitized for a range of several per cent while in measuring contamination of community air the instrument range would be 100 parts per million or less.

Other air-pollution problems for which such instruments have been sensitized include organic vapors (as represented by hexane), carbon tetrachloride, methyl chloride, and so on.

***Hose in Process Control.*** As indicated earlier, our original interest in such instruments was measuring trace concentrations of contaminants in air. We soon found that the ability to differentiate selectively between a variety of similar compounds and to monitor one of those in either gross or minute concentrations, made such instruments ideally adapted to process control leading to more efficient production: as, for example, in preventing the poisoning of catalysts in chemical and petroleum processing; improving product quality by providing a continuous measurement of impurities in a product stream; and by reducing the loss of product to waste streams.

There are an almost unlimited number of industries in which such instruments are being used. As an example, in the petrochemical industry which is currently stripping large quantities of propane and butane from natural gas, accurate analysis before and after such separations is becoming extremely important.

Such instruments are being used to measure the water content of fuel gases, air, and combustion products, the latter particularly in the field of metallurgy where such gases are used for annealing, brazing, and tempering operations. Such instruments are in use calibrated for a full-scale range of dew points from —100 to —30 F upward to those whose upper limit has been a dew point of +100 F. In some instances instruments may be dual-range units to monitor the water content of the fuel gas and the combustion products.

Several such instruments are in use measuring a few parts per million of acetylene as a contaminant in a stream of ethylene. Others of similar sensitivity are measuring contaminants in process streams of hydrogen in ammonia-synthesis and hydrogenation plants.

Recently added to the selection of infrared analyzers available on the market today is a smaller, more compact, instrument which operates on the deflection principle of indication. It brings to the user a high degree of selectivity and sensitivity at a cost considerably less than earlier models.

# Briefing the Record

## Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Acting Editor*

### Shippingport Reactor Vessel

THE shell of the 235-ton reactor vessel, the heaviest single component for America's first full-scale commercial nuclear power plant, was shipped from the Chattanooga, Tenn., plant of Combustion Engineering, Inc., on Sept. 25, 1956. The reactor vessel will be installed at Shippingport, Pa., in an electric generating plant which Westinghouse Electric Corporation is designing under contract with the Atomic Energy Commission for operation by Duquesne Light Company.

The vessel was built by assembling sections of the heaviest clad plate ever rolled by Lukens Steel Company and by developing special welding, machining, and heat-treating techniques at the Chattanooga shops of Combustion Engineering, Inc. Initial net electrical output of the Shippingport Power Plant will be 60,000 kw, but a turbine-generator of 100,000-kw capability will be installed in anticipation of the possibliity of greater nuclear capacity in the future.

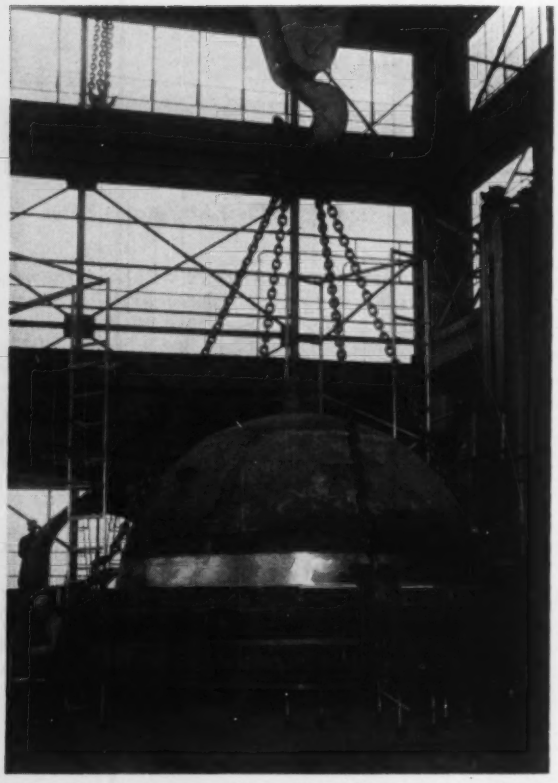
Numerous problems involved in the design required reliance on fundamental theory in order to obtain solutions. Accepted formulas for determining stresses and thicknesses were no longer applicable in a vessel with the thicknesses of plate and forgings involved. In addition to pressure and thermal stresses due to start-up conditions, consideration had to be given to heat generation in the vessel wall resulting from neutron and gamma-ray flux emanating from the nuclear-fission process. As a result of the design, development, and manufacturing experience in the reactor vessel, it is anticipated that new criteria and new formulas will be standardized in order to facilitate future design of this type of equipment.

#### Vessel Description

The reactor vessel is designed to withstand a 2500-psig internal pressure at 600 F. At rated load, 26 million lb of primary coolant water will enter the vessel each hour through four inlet nozzles and pass through the core where the temperature will be raised from 507 F to 542 F. Dry weight of the vessel is 235 tons, of which the shell portion weighs 150 tons and the removable top head 85 tons. In addition, the vessel will contain thermal shields, a core assembly, and other equipment having a total weight of an additional 100 tons. The internal diameter is 9 ft 1 in. and the length from the inside of the lower head to the inside of the top head is 31 ft 3 in.

The top head is fastened to the shell section by means of 42 6-in-diam studs, 80 1/2 in. long. Each stud with its accompanying nuts weighs 700 lb. To secure the head to the vessel shell, these studs are elongated by heat supplied from electric heaters extending into the center of the studs so that the nuts can be turned through a predetermined angle to induce the required stud tension when the studs cool to ambient temperature. The stud tension required to maintain contact of the mating

Shell of the 235-ton reactor vessel designed and built by Combustion Engineering, Inc., for America's first full-scale commercial nuclear power plant at Shippingport, Pa.



**View of 85-ton removable head, hemispherical portion of which will have 46 openings for fuel-handling equipment, instrument leads, and control rods**

surfaces of the head and shell under design conditions is 40,000 psi. Removability of the head is a design requirement to enable servicing of the internals of the vessel.

Since the hot primary coolant water circulated through the reactor vessel is corrosive, the internal portions of the vessel are clad with a $^1/_4$-in. minimum thickness of a corrosion-resistant stainless steel. The hemispherical bottom head and shell courses were fabricated from manganese-molybdenum clad plate having 6-in. and $8^3/_6$-in. minimum, thicknesses respectively. These integrally clad plates were fabricated by Lukens Steel Company. The massive head and shell flange forgings, each weighing approximately 65,000 lb and having a cross section of approximately 24 sq in. and the 10-in-thick hemispherical portions of the removable head could not be procured with the stainless steel integrally clad. In order to clad these thicker sections, a special device for cladding the base metal by weld deposit was developed at the Chattanooga shops.

Neutron and gamma radiation, if not reduced in intensity at the vessel shell, would generate heat in the shell inducing thermal gradients which would cause extremely high shell stresses. The thermal shields which surround the core assembly reduce the gamma-ray intensity at the shell to a safe level. To remove the heat generated in the shield, 15 per cent of the primary coolant flow is directed up along the shields and vessel walls prior to passing through the core. The flow baffle attached to the lower portion of the shields distributes the flow evenly across the diameter of the core.

The removable head has its hemispherical portion penetrated with 46 openings in which are attached housings which allow entrance of fuel-handling equipment for removing spent fuel elements, instrumentation leads, and control rods to control the core reactivity. The alignment of the control rods over a distance of 18 ft from the top of the head housing to the core assembly must be carefully controlled. Control of the core activity depends on the operation of the control rods. They assure proper functioning of these rods; the over-all alignment from the top of the control-rod housings to the core assembly was held to less than 0.11 in. per ft. Alignment jigs attached to three points on the shell flange will guide the head into its proper location during installation.

The vessel will be supported by 24 brackets located 3 ft below the centerline of the outlet nozzles. These brackets will support a total operating weight of approximately 385 tons.

## Vessel Material

The base material is manganese-molybdenum steel, meeting the requirements of the ASME Material Specification SA-302, Grade B, which calls for a minimum tensile strength of 80,000 psi. The specified composition is manganese 1.10 to 1.50, molybdenum 0.40 to 0.60, and carbon 0.27 max. The mill has demonstrated that the required tensile properties can be provided with carbon less than 0.25, which is the maximum permitted in plate up to 4 in. thick, this being the thickest plate for which this specification was written.

The stainless cladding is AISI Type 304-L, 18 per cent chromium, 8 per cent nickel with a maximum specified carbon of 0.03 per cent.

The bond between the cladding and base metal must be sufficient to meet the shear test requirements under ASME Specification SA-264 and the continuity of bond was assured by ultrasonic reflectoscope inspection of 100 per cent of the plate surfaces. The quality of the base plate, as regards inclusions and soundness, was also checked by this method.

## Fabrication

The procurement of plate material presented one of the more difficult problems of the program. This involved getting very thick and heavy clad plates with an integral bond between the clad and backing plate. This was the largest plate of this type ever rolled by Lukens Steel Company. The plate, after being rolled, was examined over every square inch of its surface by the ultrasonic method of inspection for both integrity of bond and backing plate.

The flanges for the vessel and heads presented difficult alloy-forging problems, which were finally solved by Bethlehem Steel Company. These are the largest manganese-molybdenum steel forgings ever made. Forming of the shell involved the maximum 6000-ton capacity of the Combustion Engineering hydraulic press equipment. Plates formed were, in all cases, heated to elevated temperatures, and special precautions were observed by the company's metallurgists in order to maintain metallurgical and physical properties.

After forming the parts, mating edges were machined

to provide welding grooves to allow joining parts in order to make a large assembly. All of the welding operations were required to be performed while the parts were kept hot thereby increasing the difficulties of fabrication. Welding through the thicknesses involved (up to 10 in. thick) required close control of the welding technique to insure the highest quality of the end product.

Radiographing of the welds joining the various parts was performed on the 15-million-volt betatron. This machine is so sensitive it will readily detect a defect that is no larger than a $^1/_8$-in. length of a standard toothpick in the weld deposit in a 10-in-thick piece of material.

Heat-treatment of all welds was done in large heat-treating furnaces at elevated temperatures to relieve the stresses in the material. On some parts the accumulated heat-treating time over the fabrication on processes amounted to about 60 days.

All clad surfaces were inspected with a dye-penetrant fluid to insure against any minute flaws. All the backing-plate surfaces were inspected with a magnetic-particle test to insure freedom of defects.

The final machining operation involved a period of approximately 60 days on one of the world's largest boring mills. The machining operation was performed using optical methods to align various matching machined surfaces giving the highest degree of accuracy possible for details of this type.

The great weight of the vessel, 150 tons without the head, caused constant settling of the setup, even though a tremendous slab of reinforced concrete supported the face plate. In addition, temperature variations from day to night caused "crawling" and required periodic checking and realignment to keep the vessel aligned to the column of the machine. Even the precision measuring equipment of the boring mill itself had to be checked periodically due to the large sizes involved.

The over-all fabrication time involved a period of about 16 months.

### Heavy Component Facilities

Because of the exceptional weight, large physical dimensions, and accuracy of machining required for reactor vessels of the type fabricated for the Shippingport station, the Chattanooga Division had to install many new facilities. A special bay, 80 ft wide and 360 ft long, was built to handle heavy components for nuclear work. This new bay is equipped with a 250-ton crane located 62 ft above the floor and another 75-ton crane on a lower level. An extension to this bay 170 ft in length is currently being constructed.

### Vessel Testing

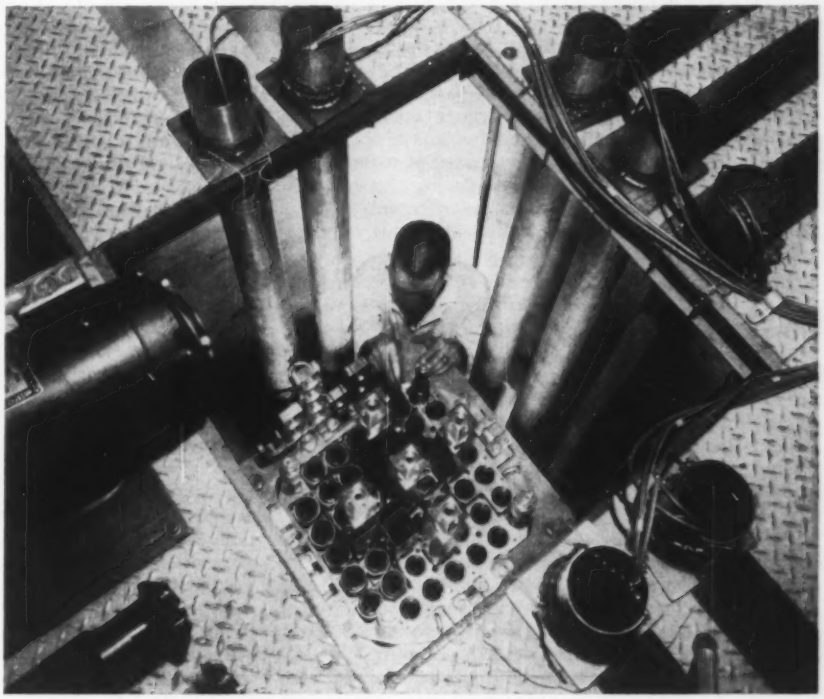
Two $^1/_4$-scale steel models of the PWR vessel were fabricated and tested to verify the stress levels in areas of structural discontinuity. The vessels were subjected to internal pressure, and strain-gage readings from over one thousand strain gages were recorded and converted into stress. External forces and moments were applied to the inlet and outlet nozzles, and strain gages recorded the response of the shell to the external loadings.

A full-diameter test vessel has been constructed and this vessel will be subjected to a series of tests to further substantiate the design calculations. Thermal cycling tests will be performed to establish rates of start-up and shut-down and to establish other basic information concerning the thermal response of the shell. Additional problems such as housing alignment will also be studied on this full-diameter test vessel.

## Atomic Criticality Facility

A NEW nuclear criticality facility for conducting experiments in connection with its atomic-power development program has been opened by Alco Products, Inc., of Schenectady, N. Y.

This facility is one of the first privately owned nuclear laboratories of its type in the country and is being used to perform experimental reactor studies to check



**View of the reactor core for the Army Package Power Reactor which ALCO is building at Ft. Belvoir, Va., for the U. S. Army. The reactor is undergoing tests at the company's new criticality facility at Schenectady prior to installation in the APPR. Shown are the core structure, fuel elements, and control rods of the nuclear generating plant.**

calculations against actual reactor performance and provide new insights into the atom as a power source.

Early experiments and studies at the facility will be in connection with ALCO's contract to build the Army Package Power Reactor—a 2000-kw pressurized-water nuclear generating plant now being built at Fort Belvoir, Va. The APPR project is under contract to ALCO from the U. S. Atomic Energy Commission and the Army Corps of Engineers.

The new laboratory will collect information on the reactor core destined to power the APPR when the latter project is completed next year.

These experiments, together with later studies to be performed by ALCO scientists, will take place within the new building at zero-power level.

In operating the ALCO criticality facility, first priority will go to protecting the worker and the public from potentially hazardous radiation. Health physicists, detection meters, film badges, and detailed records are all part of the elaborate safeguards used to insure that employees and the public never get exposed to radiation beyond maximum levels established by the AEC and recently enacted New York State regulatory code rules.

Residents of the area will be protected by filters that cleanse air exhausted from the building. The filters provided will remove more than 99 per cent of any radioactive particles before the air leaves the stack. The air will be constantly monitored to make certain that the outflow is well below permissible discharge levels at all times. Water discharged to the Mohawk River will be similarly monitored for radioactivity prior to discharge to prevent any possible pollution of this natural resource.

The new ALCO facility includes a two-story reinforced-concrete reactor room, together with a control room, "counting room," and administrative offices, all in a one-story extension.

The reactor room is 40 × 30 ft and 30 ft high, housing a 2500-gal unpressurized reactor water tank supplied by a 3500-gal storage tank in the basement of the building. The reactor tank can be evacuated of water in an emergency and the reactor shut down, by the use of a quick-opening valve. An important feature of the facility is its adaptability for study of a wide range of reactor types.

## Atomic Energy Report

ACCORDING to the twentieth semiannual report of the Atomic Energy Commission, progress was made during the first half of 1956 in every principal aspect of the nation's atomic energy program.

### Peaceful Uses

The notable progress of the past 6 months toward designing, constructing, and operating nuclear power reactors to generate economically competitive electricity in the United States included the following:

The Commission issued and put into effect basic regulations on industrial development of power.

The Commission issued the first construction permits for two large power reactors, those of the Consolidated Edison Company of New York, and of the Commonwealth Edison Company of Chicago. Both are to be built without financial assistance from the government. Applications were received for licenses to construct 10 reactors of various types, including two for the generation of power.

A fifth industrial combination—General Electric Company and Pacific Gas and Electric Company—planned to build a small power reactor without govern ment assistance. It received such a construction permit.

The Commission contracted with the Yankee Atomic Electric Company of Boston, Mass., to assist in developing a 134,000-kw power reactor. The company will bear the construction costs. The Commission will contribute to research and development costs and will lend certain other assistance. This is the first contract to be entered into under the Power Demonstration Reactor Program.

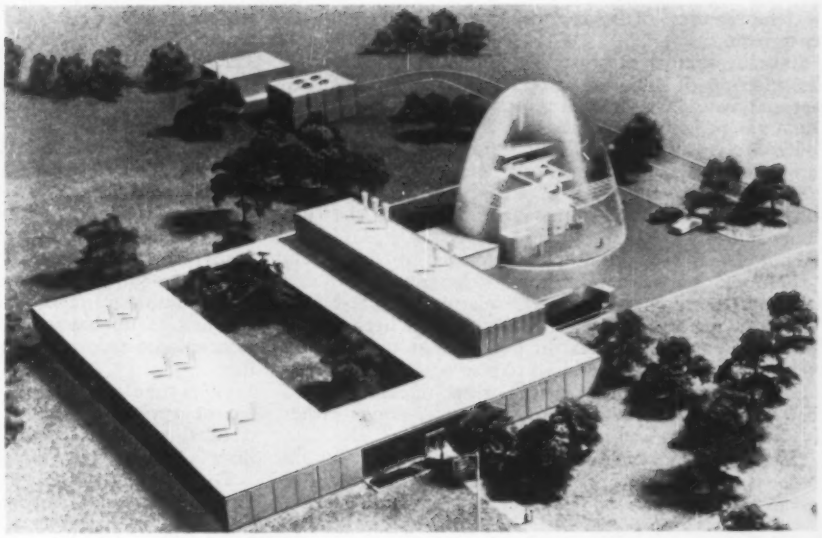
Six public and co-operative organizations and one university submitted proposals to the Commission to build small power reactors under the Power Demonstration Reactor Program.

The Commission undertook work on four additional concepts potentially useful in power-reactor design, making nine in all that were under study or to be constructed.

Construction of the Shippingport, Pa., Pressurized Water Reactor, planned for operation in 1957, went ahead on schedule. This will be the first large nuclear electric generating station in this country.

Altogether, private and public organizations have indicated that they are prepared to expend $358 million on power reactors. This exceeds the $313 million which the government, under plans existing at the end of June, 1956, would invest in experimental reactors and contributed to some privately built and operated demonstration reactors. Some $210 million is indicated as industry's investment in power reactors to which the government will make no financial contribution. Estimates were for investment by industry of $20 million in the government's experimental nuclear power-reactor program and of $128 million in the Power Demonstration Reactor Program. The government's outlay was estimated at $236 million in the experimental program and $77 million in the demonstration program. The total electrical capacity envisioned by the plans for civilian nuclear power development as they stood in late June came to 1,182,000 kw. Those which the government would only license, not help finance, could total 673,000 kw.

It has been estimated that the use of radioisotopes for research and in various processes in industry and agriculture already is repaying the nation a dividend of several hundred millions a year. This dollar figure does not take into account the value to mankind of these substances as scientific tools, diagnosis, treatment, and scientific study of human diseases and their consequent alleviation of human misery. During this reporting period, to further the use of radioisotopes, the rules governing distribution were simplified. Earlier, the Commission had reduced by 80 per cent the prices of reactor-produced radioisotopes used domestically for biomedical and agricultural research. In the 6 months, 304 additional users applied for radioisotopes raising the total to 3279. There were 5875 shipments, including 369 for export. Training courses in handling radioisotopes, from which 2500 persons already have been graduated, continued to increase the benefits of radioisotopes at home and abroad.



Ten of America's large corporations have formed a new company, Industrial Reactor Laboratories, Inc., to build and operate a privately owned nuclear reactor for industrial research in atomic energy, at Plainsboro, N. J. A model of the Laboratories is shown here. The companies participating are Atlas Powder Company, AMF Atomics, Inc. (Subsidiary American Machine & Foundry Company), American Tobacco Company, Continental Can Company, Corning Glass Works, National Distillers Products Corporation, National Lead Company, Radio Corporation of America, Socony Mobil Oil Company, United States Rubber Company.

### Military Development

The emphasis in the military-applications program during the last 6 months was upon research and development related to expanding the categories of nuclear weapons, including those intended primarily for defense. Production continued in accordance with the President's directive. Production and ordnance facilities are being expanded.

A series of tests of atomic weapons—"Operation Redwing"—were carried on at the Eniwetok Proving Ground in the Pacific. Two detonations, one of which was in the megaton range, were witnessed by pooled representatives of U. S. news media—the only Pacific tests covered at first hand by newsmen in 10 years. Civil Defense official representatives also observed the tests.

The current tests involved weapons generally smaller in yield than those tested during the 1954 series. The energy yield of the largest test fell substantially below that of the maximum 1954 test.

The programs for design and construction of military nuclear reactors continued to expand. These reactors are an important influence in accelerating practical development of all nuclear power plants, including those for civilian use.

The naval reactors program, a joint undertaking of the Commission and the Department of Defense, is aimed at developing a series of nuclear power plants designed to propel many sizes of naval ships from submarines to aircraft carriers. Construction of a second nuclear-powered submarine, the USS *Seawolf*, neared completion. A radar picket submarine, the largest submarine ever to be built and the first powered by two nuclear reactors, was authorized by the congress.

The Army program now includes three major projects: a package power reactor being constructed at Fort Belvoir, Va., a smaller low-powered reactor, and a reactor to assist in experiments with radiation as a tool for food preservation. Other advanced reactor systems were under consideration, including a gas-cooled type.

Research and development activities on aircraft nuclear power plants progressed satisfactorily, and new test facilities were programmed for the National Reactor Testing Station in Idaho.

### Controlled Thermonuclear Program

The Atomic Energy Commission's program of research on the controlled release of nuclear energy from fusion continued during the first half of 1956 at three major sites—Los Alamos Scientific Laboratory, Los Alamos, N. Mex., the Livermore, Calif., laboratory of the University of California Radiation Laboratory, and at Princeton University, Princeton, N. J. Smaller projects were carried forward at New York University of New York City, and Oak Ridge National Laboratory at Oak Ridge, Tenn.

Although it may be possible to use a number of light elements in the fusion process, the Controlled Thermonuclear Program has as its ultimate goal the controlled release of energy from the fusion of deuterium (heavy hydrogen) nuclei, and the use of this energy to provide an economic source of power. Since deuterium occurs in great abundance in sea water, it would constitute a source of energy virtually without limit.

As contrasted with the fission process, in which a very heavy nucleus is split into lighter nuclei, the fusion process being studied under the Controlled Thermonuclear Program involves a merging of two extremely light nuclei to form a heavier nucleus. Both processes are accompanied by a release of energy. In order to bring about fusion, sufficient kinetic energy must be provided to light nuclei so that they can overcome their mutual electrostatic repulsion and approach close enough to each other to allow fusion to occur. Accomplishing this will require creating a system in which light particles move in more or less random directions and are reflected many times from confining barriers before either escaping or undergoing fusion. It is estimated that the energies that would have to be provided to light nuclei so as to overcome their electrostatic repulsion correspond

to temperatures of several hundred million degrees centigrade.

Since at these temperatures—equivalent to those in the interior of the sun—a reaction chamber of any material would vaporize instantly, another method of containment has to be devised. The only thing which conceivably is capable of containing this type of reaction is an electric or magnetic field, which might be used to insulate the walls of a reaction chamber from extremely high temperatures at the center of the container.

Thus, in essence, the problem involved in controlling a thermonuclear reaction is that of ionizing a suitable material (such as deuterium), heating the resulting plasma to temperatures of 100,000,000 C or higher, and confining it at this temperature long enough to permit an appreciable fraction of the ions to fuse with a consequent release of energy. The energy thus released would then have to be converted into electrical power either directly or through suitable heat exchangers.

Each laboratory engaged in the program is pursuing a somewhat different approach to this problem. The research certainly is on a very long-term basis, but it is probable that success will be achieved eventually. It is, however, reasonable to expect that an approach as yet unformulated may yield the greatest promise of success.

A number of statements can be made about the probable characteristics of a fusion reactor. Any thermonuclear power unit gives promise of being extremely safe. The amount of fuel within the thermonuclear machine at operating temperatures would be simply that required to sustain a normal power output of the device at any instant, and this amount would be extremely minute. The fuel supply itself would be stored outside the machine chamber and would be wholly incapable of participating in the reaction without first being introduced into the reactor and heated. The possibility of a serious accident due to failure of a component or to human error seems virtually negligible. In addition, there probably would be no fission products to escape in case of an accident.

Any thermonuclear reactor that consumed hydrogen isotopes as a fuel would produce intense fluxes of neutrons. As a result of the copious yields and high energies of the neutrons involved, care would have to be taken to provide adequate shielding from this radiation. It is conceivable that a controlled thermonuclear reactor (burning a fuel of helium 3, for example) might eventually be developed which would produce no neutrons at all, and for which no neutron shielding would be required. Such a reactor is purely of academic interest for the forseeable future, since the temperatures which would have to be achieved in this case to energize the helium atoms would be much greater than even the enormous temperatures required for deuterium.

## Stresses in Metals

RECENT work at the National Bureau of Standards has provided new information on the distribution of stresses between crystals in a metal. Studies of changes in the lattice spacing of crystals, both under load and after release from load, were made by x-ray diffraction. It was found that the magnitude and direction of the principal stresses can be computed for a certain loading condition in this way even though the elastic limit has been exceeded.

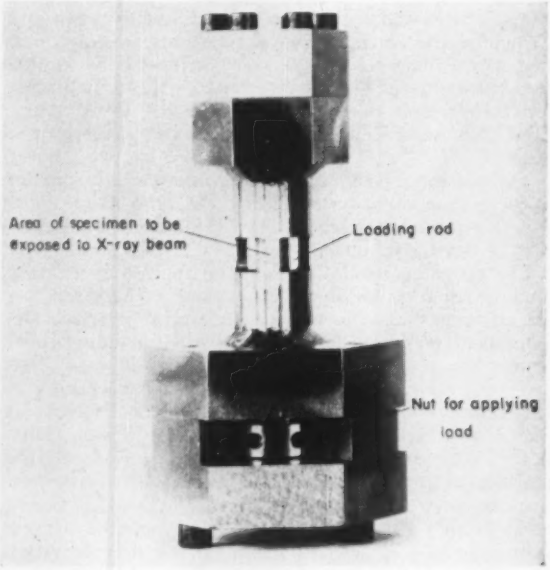
The Bureau investigations have also led to a new explanation of the balancing of residual strains. These results should not only increase the practical utility of stress measurement by x-ray diffraction but should also prove useful in basic studies of metal fatigue and corrosion.

Previous work at the Bureau and elsewhere has shown that there is a certain range of applied stress over which the crystal lattice behaves elastically; beyond this point the strain as measured by x rays remains nearly constant although the metal continues to deform. Also, when the load is released, a residual strain is left, opposite in sign to that under load. The present investigation sought to answer such questions as the following:

(1) Is the elastic limit the same in all directions relative to the applied stress? (2) What is the nature of the residual strain observed after plastic deformation and how is the stress causing this strain balanced?

To provide the necessary data, an investigation of lattice strain in 17 directions in a low-alloy steel was conducted. Measurements were made both under load and after release of load, the successive loads being of increasing magnitude.

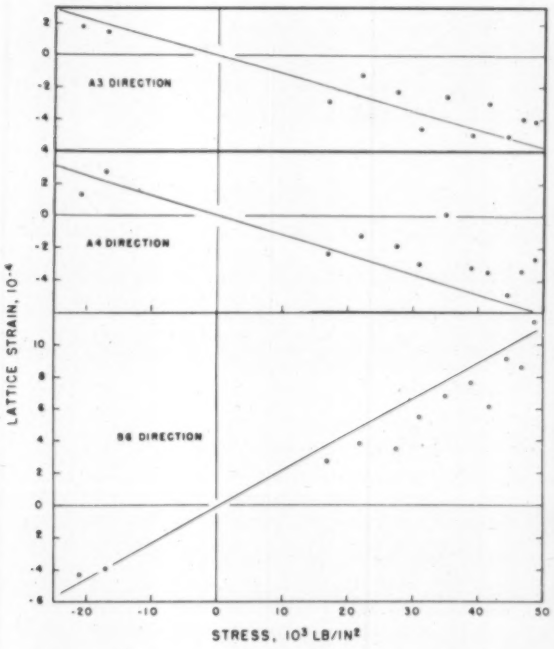
A change in lattice spacing causes a change in the diffraction angle $\theta$, so results of the experiment were summarized in diagrams showing the change in -tan $2\theta$ with load. At low stresses, the graph of -tan $2\theta$ versus load is a straight line, the slope of which is termed the lattice compliance. Deviations from this compliance line (i.e., the elastic limit) occur at lower stress for the




**Specimen and loading system used to study the distribution of stresses between crystals in a metal. The specimen is essentially a hollow cylinder with portions machined away to leave three triangular legs. The nut threaded on the loading rod applies a compressive load with a clockwise turn and a tensile load with a counterclockwise turn. In the complete assembly the specimen and loading system are mounted on a two-circle goniometer. An x-ray beam strikes the surface at any desired angle to measure interplanar space changes caused by strain.**

positive compliance (stress and strain acting in the same sense) than for the negative. This was found to be generally true in all directions investigated. The average stress values at which the deviations occurred were 23,000 psi and 40,000 psi for positive and negative compliances, respectively.

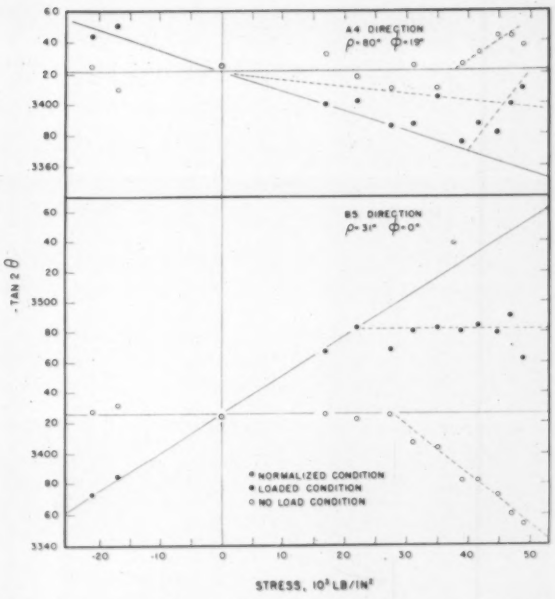
A study of the variation of lattice compliance with direction indicated that shear and transverse stresses were superposed on the loading stress. Analysis showed that if such stresses were assumed to be proportional to the loading stress, then the experimental values of compliance could be adequately represented by an equation derived from the elastic theory for a homogeneous medium. This implies that the ellipsoid of elastic strain is the same in all crystals measured, from which, if true, it can be deduced that there are steep stress gradients in the vicinity of the crystal boundaries.




**Experimental results from the NBS studies on strains in metals by x-ray diffraction methods. The strain values after the load was released are plotted on the abscissa values corresponding to the load. When strain measurement was made in a direction nearly perpendicular to the surface of the crystal, it was found that the strain was compressive when the applied stress was in tension, and vice versa. At an angle of 31 deg the stress and strain were in the same sense.**

It was found that the values obtained for the difference in tan $2\theta$, expressed as strain, which occurred on release of load for stresses greater than the elastic limit, could be predicted from the lattice compliance computed from the previously mentioned equation. This indicates that the magnitude and directions of the principal stresses can be computed for a certain loading condition from the change in lattice spacing on release of load even though the elastic limit has been exceeded.

Other investigators had previously noted the development after plastic deformation of residual stresses opposite in sign to the applied stress, and various explana-




**Graph showing the total change in lattice spacing on release of load plotted against the previously applied load. The slopes or compliances of the solid lines are computed from the equation for the elastic behavior of a homogeneous medium. This implies that the ellipsoid of elastic strain is the same in all crystals measured, thus indicating steep stress gradients in the vicinity of crystal boundaries.**

tions have been offered to account for the necessary balancing stress. One theory is that the stresses are due to the anisotropic behavior of individual crystals and are balanced by opposite stresses in adjacent crystals of different orientation. The Bureau's results do not support this theory, as a wide range of orientations were studied and all of the residual strains appeared to arise from a single stress system.

It has also been suggested that the observed stress occurs only in the surface layers of the plastically deformed specimen, the balancing stress being present in the interior. Another study conducted by the Bureau indicates that this theory does not hold. Two specimens of ingot iron were plastically deformed, one in compression, the other in tension. Sections were cut from the bars at angles of 0, 30, and 90 deg to the axis along which the stress had been applied, and x-ray strain measurements were made on the surfaces of these sections. Assuming that cutting of the specimen relieved stresses normal to the new surface and that stresses parallel to this surface were not affected by the sectioning, it was possible to reconstruct the residual stress system existing in the bars before they were cut. These were found to be similar to those previously found on the outside of specimens, namely, a compressive stress in the tensile specimen and vice versa.

As the experimental results do not agree with any of the current theories, the NBS investigators propose the following explanation for the balancing of the observed residual strains: This balancing is supplied by stresses in material in which the crystal lattice is so distorted that it does not scatter x rays coherently. Such material might be found at grain boundaries or in slip bands.

Inside this tank-like electric furnace, steam at 1200 F and 16,000 psi is being used to test the strength of the stainless-steel casing which will "house" the superpressure element of a new type Westinghouse steam turbine. Here, E. A. Davis adjusts laboratory apparatus which shows the behavior of structural metals under these extreme conditions of heat and pressure.

Heated to 4000 F in the airless glass chamber of this high-temperature vacuum furnace, an experimental metal alloy is treated by Dean Lawthers. An atmospheric pressure one billion times rarer than can be designed to explore metals of the future, Westinghouse scientists have produced in this furnace an alloy which, above 1800 F, is stronger than any other known metal.

## Westinghouse Research Laboratories

FORMAL dedication of the new Research Laboratories of Westinghouse Electric Corporation took place on Sept. 13, 1956. Located on a 72-acre site in Churchill Borough, ten miles east of Pittsburgh, the Laboratories contain unusually complete and up-to-date facilities for scientific research.

Work in the Laboratories is organized into 11 departments. These include chemistry, electromechanics, electronics and nuclear physics, insulation, magnetics and solid state physics, mathematics, mechanics, metallurgy, physics, semiconductor and solid state physics, and technology.

Facilities include a complete metals-processing laboratory for melting, annealing, rolling, and otherwise processing metals and alloys; an instruments laboratory; several machine shops; a glass-blowing laboratory; a photographic and reproduction department; drafting facilities, and other services necessary to the functioning of a modern research organization.

Equipment in the Laboratories ranges from such items as a 15-ton bearing test machine to a quartz-bar microbalance which is suspended on a wire finer than a human hair and would be taxed to capacity if required to weigh more than a single speck of dust. A cryostat, a king-sized refrigerator, can plunge temperatures to near absolute zero (459 F). Elsewhere, the atmosphere of outer space is approached with delicate apparatus which will create nearly perfect vacuums. Westinghouse scientists have achieved pressures as low as one millionth of a billionth of an atmosphere.

More than 700 men and women are at work at the Laboratories of which some 450 are professional scientists, laboratory technicians, and assistants. Of the professional personnel 38 per cent are physicists, 24 per cent are chemists, 13 per cent are electrical engineers, 11 per cent are mechanical engineers, 7 per cent are metallurgists, and 4 per cent are mathematicians. Of the men hired from colleges and universities in 1956, 72 per cent held doctor's degrees.

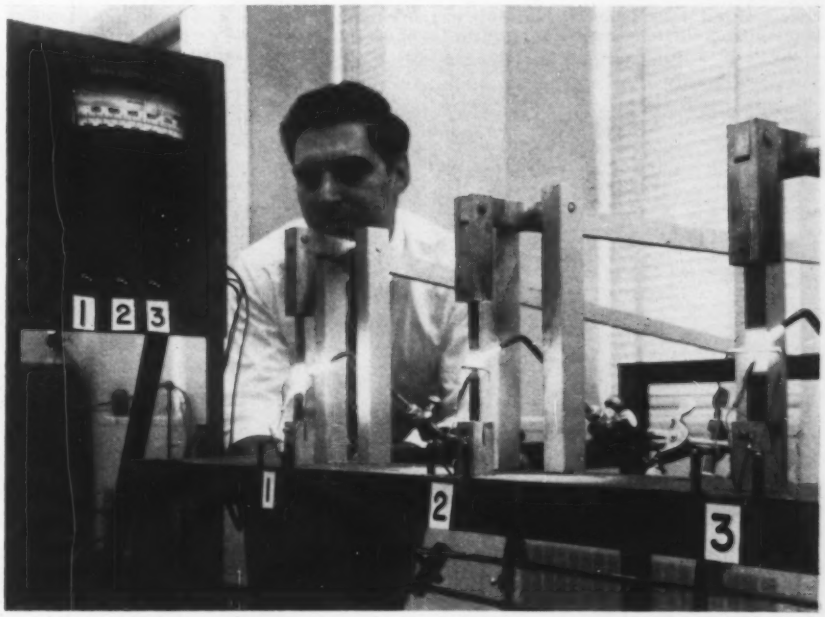
The library contains some 30,000 volumes and, in addition, subscribes to some 500 periodicals, including technical journals and other publications in German, Russian, Japanese, French, and a variety of other foreign languages.

About 30 per cent of the Laboratories' research effort is in "blue-sky" projects—in work fundamental to the electrical industry, but not directed toward a particular product development. About 55 per cent is co-ordinated with long-range plans of product divisions, most of it being basic research. Eight per cent is taken up in governmental activity. Seven per cent is devoted to product development mostly in highly specialized fields.

Modular planning was the key in designing the three-story L-shaped structure that houses the new Research Laboratories. Each module measures 6 ft along the window wall and either 19 or 25 ft in depth. This is the smallest repetitive unit of space that is completely equipped with laboratory and building services.

Using steel balls to simulate electrons, Dr. R. E. Fox demonstrates the ability of sulphur hexafluoride to quench an electric arc. *Right*, model represents conventional air; *left*, the new gas. When an electron (ball) is released, *right*, it triggers an avalanche of electrons, considered the electric arc. *Left*, avalanche never begins because the holes capture balls. The holes demonstrate the electron-capturing property of the gas.

Dr. M. A. Biondi, Westinghouse research physicist, uses ultra-frequency microwaves to study the superconductivity of metals at temperatures less than one degree above absolute zero, minus 459 F. Liquid helium is used to cool the metal sample. Purpose of the research is to learn why certain metals, at low temperatures, permit electric currents apparently to flow forever.




J. H. Bechtold, manager of the Westinghouse Research Laboratories' metallurgy department, demonstrates how Inconel-clad molybdenum withstands high heat, while molybdenum or Inconel, alone, each fails. Sample 1 is pure Inconel which has poor strength but good heat resistance. Sample 2 is pure molybdenum which has high strength but oxidizes and disintegrates too easily from heat. Sample 3 is Inconel-clad molybdenum, having only the best properties of both. The Inconel-clad metal, a new supermetal for possible jet engine application, gives promise of increasing engine efficiency more than 15 per cent.

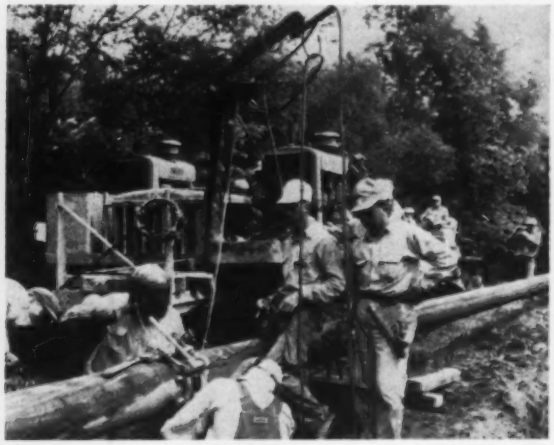
## Coal Pipeline

WITHIN a short time, coal should be flowing over the hills of Ohio through this 10-in. pipeline, running 108 miles from the Hanna Coal Company strip mines, south of Cadiz, Ohio, to the Cleveland Electric Illuminating Company's Eastlake Generating Plant, just east of Cleveland. The coal, pulverized and suspended in water, will be pumped through the line at a rate approximating $3^1/_2$ mph, then dried and fed into the station steam-generating boilers. It is anticipated that the line will be capable of delivering 1,300,000 tons of coal each year. The Pittsburgh Consolidation Coal Company, after 5 years of research, decided that this was a feasible way to transport coal and is now in the process of making this idea a reality. Ford, Bacon & Davis, Inc., is responsible for the engineering design and supervision of the construction of the pipeline and pump stations. Williams Brothers Company is the pipe-laying contractor and Poling & Bacon Construction Company is the station contractor.

The line, the first of its kind in the United States, involved some interesting welding, since, because of the erosive-corrosive nature of the material being transported through the pipe, it was necessary to use heavy wall sections and high-tensile steel. Five different pipe-wall thicknesses were used. Sixteen passes were used on the heavy-wall pipe. All pipe used was 5LX-42 specification. The bulk of the pipe was furnished with a 30-deg bevel for welding on the end. A relatively small amount of pipe was furnished with $37^1/_2$-deg bevels.

Stringer beads were used for all passes, except the cap pass which was a wide weave. In cold weather, pipe was welded without preheating by not allowing the pipe to cool between passes. Filler-pass welders moved

The line-up gang, stringer-pass, and hot-pass welders approach Lake Erie and work under the high-voltage transmission lines coming from the power-generating plant to which this pipeline will carry coal



These stringer-pass welders are using 5/32-in. Fleetweld 5-P and two 300-amp diesel-driven Lincoln welders mounted on the rig in the background. The line is the first of its kind in the United States.

Three hot-pass welders are using the rig, mounting two diesel-driven welders and one gasoline-engine-driven welder. Two hot passes were made, using 5/32-in. Shield-Arc 85-P. Five different pipe-wall thicknesses were used.

Part of the filler-pass gang of 12 welders are shown here. The 7/8-in. wall pipe was welded with 16 passes; 1/2-in. wall, with 11 passes. Shield-Arc 85-P of 3/16-in. size was used for filler passes.

in quickly behind stringer and hot-pass welders. Filler-pass welders would keep two joints hot at the same time by alternating their welding back and forth between the two joints. In order to prevent underbead cracking, it was necessary to have stringer-bead welders strip three inches, top and bottom, before moving pipe to make the next line-up. The Lincoln Electric Company's Fleetweld 5-P, 5/32-in-diam, was used for stringer passes; Shield-Arc 85-P, for two hot passes; and 3/16-in. 85-P, for filler passes. Fleetwood 5 was used for the cap pass. The line used 2 men welding stringers, 3 on hot passes, and 12 on filler passes. Three Lincoln diesel-engine-driven welders and 19 gasoline-engine-driven welders supplied the welding crews.

## Ultrasonic Inspection Simulator

AN INEXPENSIVE ultrasonic rotor-inspection simulator for the training of ultrasonic inspectors of large turbine and generator rotor forgings has been developed by the General Electric Company, Schenectady, N. Y.

Designed and manufactured by engineers and technicians of the Nondestructive Testing Unit, Materials and Processes Laboratory, Large Steam Turbine-Generator Department, the simulator graphically demonstrates to the inspector the qualitative and quantitative effects of an internal defect in a rotor as well as its size and shape.

A disk of transparent plastic material was machined hollow and filled with glycerine to represent that particular section of a steel rotor forging "seen" by a testing crystal at any given instance of an ultrasonic inspection.

The use of glycerine, along with smaller piezoelectric transducer crystals than normally used for inspection purposes, insures that the relative geometry between the simulated rotor and the ultrasonic beam is comparable to that encountered during normal forging test procedures.

The device can use either of two piezoelectric transducer crystals—one of 1 megacycle and another of $2^1/_4$ megacycles.

A small electric motor rotates the transparent shell containing the glycerine. A fixed arm is connected to the shell's inner core and also rotates with the rim. This arm is slotted and small pieces of metal can be suspended in any position from the arm to simulate the flaws.

The crystal is connected to an ultrasonic flaw detector of the same type used by the factory operators in testing production rotors. Thus, flaw patterns set up on the simulator can be seen on the detector screen just as they would appear during the inspection of an actual rotor.

## Flame Ceramics

A NOVEL method of coating metals and other substances with ceramic materials, called "Flame Ceramics," has been developed at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

Most known metals are unable to withstand the extreme surface heat generated by the awesome speeds of rockets and missiles. However, with the flame-spray technique it is possible to cover rockets and missiles with a coating that will protect the undercoat from high temperatures.

Flame Ceramics is an offspring of "Solutions Ceramics," an earlier Foundation development. In Flame Ceramics, the particle is sintered as it is fed through a flame; in Solutions Ceramics the ceramic material is applied as a hot liquid.

The coatings are said to have a remarkable resistance to heat, abrasion, and chemical attack. Most coatings can be used for electrical insulation; one even will conduct electricity.

The ceramic coating is extremely effective for protecting metals, like steel and aluminum, against high-temperature erosion such as encountered in rocket nozzles. And the hardness of the coating suggests its use in protecting softer metals from wear.

Besides its obvious applications to rockets and missiles, Flame Ceramics already has shown its value in these adaptations: Antiheat protection for aircraft parts, coating for flame equipment, thermal protection for engine parts, and increasing wear and skid resistance of metal treads.

Continental Coatings Corporation of Chicago has world-wide rights to this process and the right to sublicense Flame Ceramics materials and processes.

An outstanding feature of this new process is its simplicity of application.

The sprayed composition is a powder usually composed of a single oxide, such as alumina or zirconia, with other necessary additives to give the desired coating. The powder is contained in a hopper and is blown through a flame torch.

Surfaces to be coated are sand or grit-blasted. Nonmetals do not have to be sand-blasted, but should be cleaned thoroughly.

The material that is to be coated does not have to be heated excessively. Ordinary ceramic coatings, on the other hand, require heating of both the metal and the ceramic to high temperatures.

Oxyacetylene flames are feasible for the production of some coatings, but oxyhydrogen is preferable.

The Flame Ceramic coatings can be impregnated with waxes, resins, silicones, colloidal suspensions, and other desired solutions. Silicone impregnations provide protection against acids not over 450 F.

A wide variety of physical, chemical, and electrical properties can be obtained by intermixture of many coating materials with metal, powder, cermet, glass frits, or other mineral constituents. The type of coating applied depends, of course, upon the special task the material is to perform.

For example, the alumina coating is electrically insulative and its use is anticipated in the manufacture of high-temperature-process equipment.

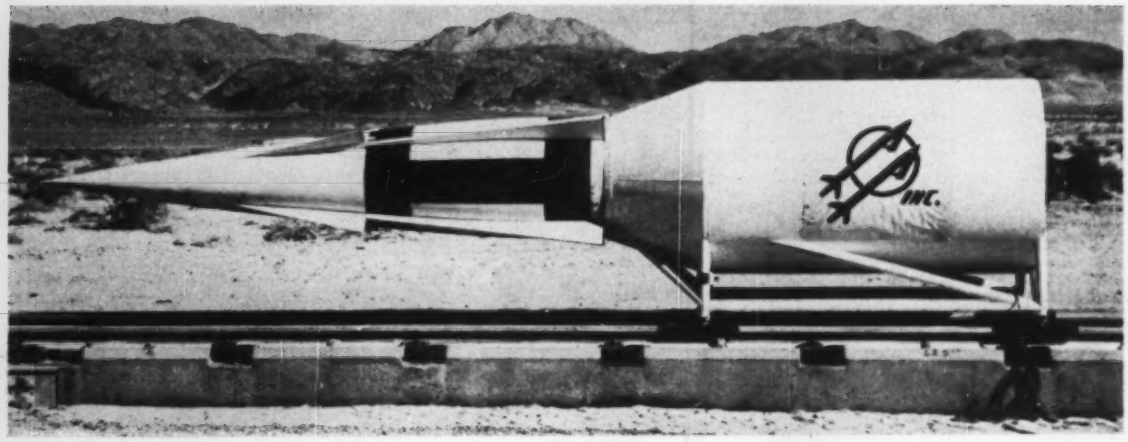
Although the zirconia coating is somewhat softer and more difficult to apply than the alumina coating, its resistance to corrosion and heat is greater.

Flame titania is said to be outstanding in its resistance to mechanical abrasion.

The adherence of the coating depends on the underlying metal. In general, the hard ferrous and aluminum alloys provide the best bonding. Adherence tends to diminish on soft aluminum alloys and copper.

Special coatings are available for the softer metals. Nickel alloys and titanium are good bases for any of the coatings if not too thickly applied.

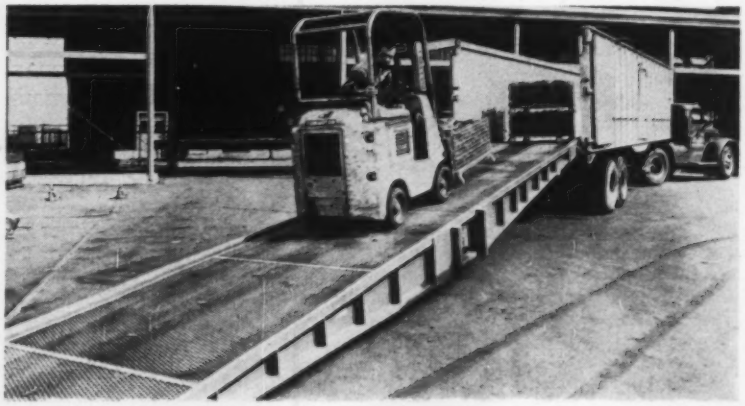
The thickness of the coatings can be increased indefinitely by continued applications. But for most applications a thickness of 0.010 in. is adequate.

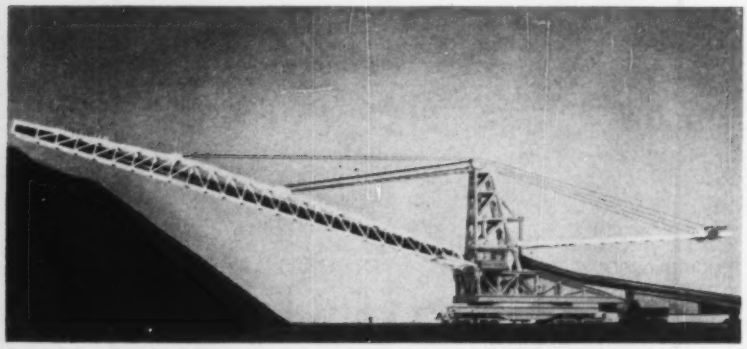



# Photo Briefs

**New Speed Record Set.** During testing recently conducted at the Naval Ordnance Test Station in California this rocket sled designed and built by Aircraft Armaments, Inc., of Baltimore, Md., under the direction of the U. S. Army, reached a velocity of 1300 mph. The heavy sled reached this velocity in less than 2.5 sec. This high velocity, believed to be a record for heavy sleds at sea level, was obtained by a set of three solid propellant rocket motors. Rocket-sled testing is a new technique developed for testing the operation of component parts at high speed.

**Portable Magnesium Yard Ramp.** Warren Webster Company, Camden, N. J., has solved a vexing castings-unloading problem through use of a portable Magnesium Company of America magnesium yard ramp. Incoming trailers are spotted immediately adjacent to the ground-level scale and storage area. The lightweight, wheeled yard ramp is moved into position by one man without aid of powered equipment. A lift truck carries "Palletainers" of castings from the trailer bed directly to the scale in one quick operation. The previous system had required moving the castings from trailer to dock, down an elevator to ground level, and then through almost 1500 ft of aisles.



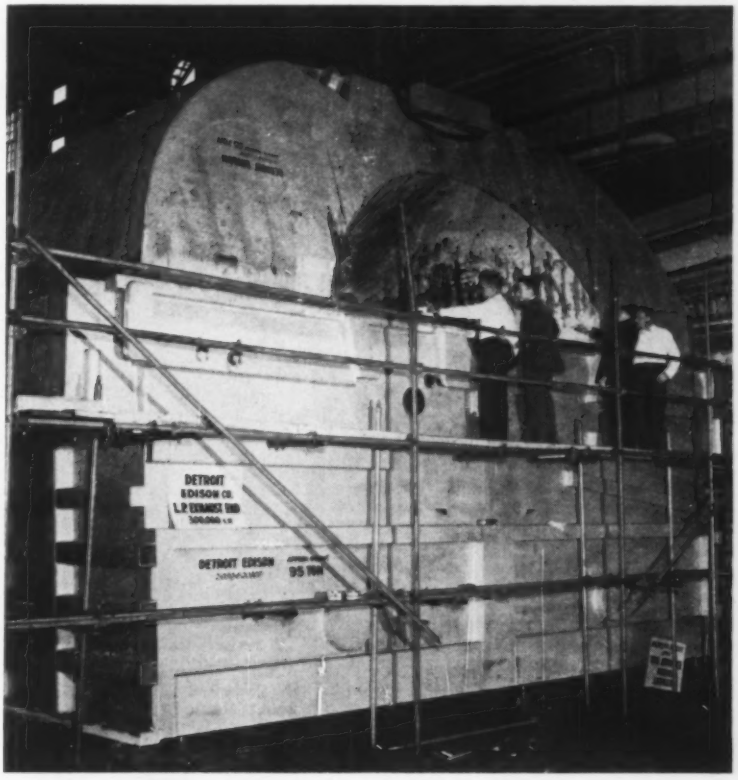


**Traveling Belt Conveyer Stacker.** This model of a gigantic 275-ft-radius self-propelled stacker was recently displayed by the Link-Belt Company, Chicago, Ill. Believed to be the world's largest, it will be used to stockpile taconite pellets produced during the five winter months when navigation on the Great Lakes is closed. It is capable of stockpiling a 90-ft-high mountain of more than 4,000,000 net tons of taconite pellets covering an area approximately 800 ft wide at the base and 1300 ft long. The stacker will be fed by a trailing belt conveyer about 1400 ft long.

**Cylindrical Grinding Machine.** A new machine for precision grinding of large, relatively lightweight workpieces has been developed by Norton Company, Worcester, Mass. Automatic or manual wheel-feed settings are speeded by means of a click-count wheel-feed index with which feed increments as fine as 0.0001 in. in work-diameter reduction are set without visual attention. Operation is simplified by a preset table truing and grinding speed-control feature. This permits maintenance of separate table speeds for truing and grinding as set from the first workpiece.

**Vacuum Chuck.** A vacuum chuck is one of the features of the new portable machine pictured above which is used to machine aluminum honeycomb material at Northrop Aircraft, Inc., Hawthorne, Calif. A piece of phenolic or aluminum sheeting is cemented to the bottom of the honeycomb part and the chuck then holds down both the sheet and the part. A pneumatically driven Keller die grinder motor cuts the material using a circular knife rotating at 30,000 rpm. The tool is fed across the work manually. A vacuum pump linked to an accumulator tank prevents surges in the vacuum-chuck system.

**Steam Turbine Casing.** Shown here under examination is one of the two back-to-back fabricated-steel low-pressure casings for the 300,000-kw close-coupled, cross-compound reheat steam turbine generator of Detroit Edison's River Rouge Plant. The casing weighs approximately 150 tons, is 30 ft wide, 21 ft high, and 15 ft deep. Both the upper and lower halves were completely fabricated in Allis-Chalmers tank and plate shop, Milwaukee, Wisc. The casing is shown here during preliminary fitting prior to boring on a 40-ft mill. The men are looking at the location of one of the low-pressure turbine bearings.



# European Survey

## Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME, *European Correspondent*

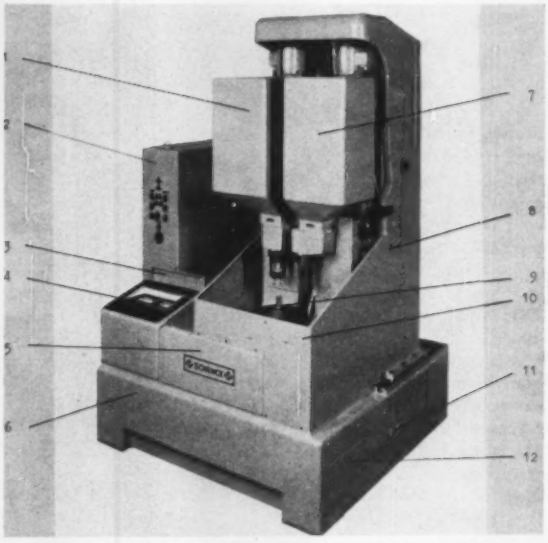
**143-ton cast-steel hammer block made by English Steel Castings Corporation, Ltd., for B. & S. Massey, Ltd., Openshaw, Manchester, England. The hammer block was installed in the 7-ton axle forge of Steel, Peech and Tozer, Ltd., Rotherham.**

### 143-Ton Hammer Block

WHAT is believed to be the largest steel casting ever made in the United Kingdom for a forging hammer block has been installed recently in the axle forge of Steel, Peech & Tozer, Ltd., at Rotherham, England. With a machined weight of 143 tons and costing $42,000, it was cast at the Grimesthorpe foundry of the English Steel Castings Corporation, Sheffield, for B. & S. Massey, Ltd., of Manchester, the makers of the 7-ton forging hammer of which it now forms part and which had originally an 82-ton block, made in two pieces. The upper section of the old block was of steel and the lower part of iron, the two being dovetailed together, but it was found that the two sections were beginning to work loose, to the detriment of the quality of the work. It was decided, therefore, to install a heavier block, in one piece, giving a weight ratio of block to hammer of 20 to 1 instead of the former 12 to 1. The new block was transported three miles by road to the Templeborough melting shop of Steel, Peech and Tozer (referred to in the "Survey" of May, 1956) where a 150-ton overhead crane transferred it to a special railway wagon supplied by British Railways, on which it was taken to the axle forge. This involved crossing the River Don, which flows through the center of Sheffield, and the bridge and tracks had to be specially strengthened to take the weight. The old block was removed, the new one placed in position and the entire hammer rebuilt, ready for work, in 16 days. The whole job was done by members of the Steel, Peech and Tozer staff, as a strike of the maintenance men was in progress at the time.

### Balancing Machine for Flywheels

THE Carl Schenck Maschinenfabrik G.m.b.H., of 55 Landwehrstrasse, Darmstadt, Germany, who are specialists in balancing machines, have produced a new model




**Balancing Drilling Machine AZ 33 EB 2K/14, produced by Carl Schenck Maschinenfabrik G.m.b.H., of Darmstadt, Germany. (1, drilling unit I; 2, control cabinet; 3, removable cover for indicator head; 4, indicator head; 5, drive for balancing spindle; 6, machine base; 7, drilling unit II; 8, boring support; 9, balancing spindle to take up rotor; 10, cover; 11, drawer for borings; 12, removable sheet giving free access to phasing generator, angular location device, and centrifugal cut-out switch.)**

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

for balancing small flywheels. Once the machine is started, operation is completely automatic, the machine first measuring the out-of-balance in two planes at right angles and then drilling out, in the appropriate positions, sufficient metal to correct it. The component to be tested is placed on the table of the machine and run up to speed, the out-of-balance values in two planes at right angles being shown on an indicator and electrically recorded. The electrical recorder transmits to the drill units the amount and the angular location of the unbalance and the drills progressively remove the metal until the out-of-balance indication is cancelled. The drills have a rapid approach feed and automatically reduce to the normal operating feed. After removing the required amount of metal, they are returned by a rapid reverse motion. The machine as shown corrects by mass compensation in one plane only, but additional drill units can be provided to operate from below, thus giving a mass correction in two planes. When drilling downward only, the work is supported from below to balance the drill pressure. Horizontal machines, operating on the same principles, are made for balancing automobile crankshaft forgings before machining and for the final balancing of machined crankshafts, the floor-to-floor time per shaft being less than two minutes.

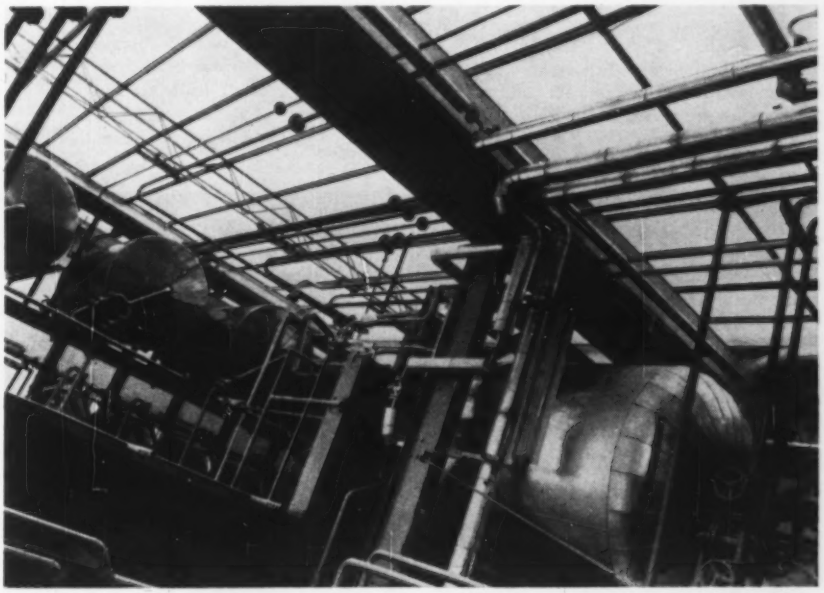
## The Bessemer Centenary

Sir Henry Bessemer was born in 1813 and died in 1898, but historically more important than either of these dates (allowing for the obvious fact that, if he had not been born, it would not have happended) was his presentation before the British Association for the Advancement of Science, on Aug. 11, 1856, of the paper in which he disclosed his method of steelmaking by the use of the Bessemer converter. It may well be regarded as the birthday of the modern steel industry throughout the world. Though nothing appears to have been done on the precise anniversary to mark the centenary, commemorations have been going on at intervals for much of this year, and they are not yet concluded. A Bessemer Centenary Lecture was delivered on May 15 before the Iron and Steel Institute in London by Mr. James Mitchell, C.B.E., a past-president of the Institute and a director of the British steelmaking firm of Stewarts & Lloyds, Ltd., and a small exhibition of Bessemer relics, correspondence, and so on, was arranged at the offices of the Institute.

In October, the Workington Iron and Steel Company, which was formed in 1856 and is now the only firm in the United Kingdom which still operates the original acid Bessemer process, staged a special exhibition; and in December a small display, of a more popular character, is being arranged by the town of Hitchin, England, on the outskirts of which Bessemer was born. The ASME, of course, has its own special contact with Bessemer through Alexander Lyman Holley (1832–1882).

## Lubricating Oil Plant for Austria

Shell Austria A. G., the Austrian associates of the Shell Petroleum Company, have now in service at Simmering, outside Vienna, a new lubricating oil blending plant and grease-producing unit. In conjunction with their refinery at Floridsdorf it will manufacture some 225 products and will be able to provide three-quarters of the entire requirements of the Austrian market. The plant covers nearly 13 acres and is in three main parts, dealing respectively with high-performance greases for automotive and industrial uses, lubricating oils, and cutting oils. The last-mentioned plant also produces lubricants for the textile industry and various derivatives of mineral oils and chemical raw materials for agricultural and horticultural purposes. The construction of the plant involved some heavy excavation, $3^1/_2$ million cu ft of earth having to be moved. In addition to the main buildings with their storage tanks, railway sidings, and so on, there is a boiler house, a transformer station, and an administrative block which also contains the laboratory. The complete project involved the provision of more than 12 miles of piping. The pipeline system has been designed to make spilling impossible.



**Wien-Simmering lubricating oil installation. The picture shows the interior of building G of the grease plant. The principle of gravity flow has been applied throughout, chemicals and oil being stored in the uppermost tanks. Pipes leading from these tanks end in a centrally-located distribution battery on the first floor and from this terminal the flow of materials is directed into the blending tanks. These insulated tanks, which are recessed into the first floor, can be seen in the *left* foreground.**

# ASME Technical Digest

## Substance in Brief of Papers Presented at ASME Meetings

### Materials Handling

**Handling by Dragline—The Workhorse of Industry,** by H. J. McCormick, Link-Belt Company, Chicago, Ill. 1956 ASME Semi-Annual Meeting paper No. 56—SA-38 (multilithographed; available to April 1, 1957).

THE operation and applications of the dragline conveying system are reviewed in this paper as one of the important methods of materials handling. Essentially the dragline is a stream of four-wheeled industrial trucks, one following another in a continuous procession, following a closed path through a warehouse, with no operators in attendance.

The towing media may be either in the floor and out of sight or located overhead, but the action and results are basically the same. Design characteristics of both are discussed as well as present-day methods of installation with emphasis on the newer or in-the-floor system.

Primarily, both systems use what is termed "rivetless chain" suspended or supported by mechanical means—either towing trolley or idler attachment—from structural members which are overhead and in turn suspended from building members, or are buried in the floor, usually in concrete. Both have drive units which for machinery are close to identical.

Both consume for operation about the same amount of horsepower. Each system "tows" 4-wheel trucks (sometimes 2-wheel), which operate on the floor, accounting for the "reasonable" chain pulls with consequent small horsepower required. Speeds are generally 120 to 150 fpm for the in-the-floor unit, whereas the overhead unit has been run as high as 180 fpm (not generally recommended). Trolley spacing on the overhead system may be as far apart as 40 in., whereas attachment spacing in the in-the-floor unit may be 36 or 48 in.

Paths traversed for either system may be close to identical—the in-the-floor system having some limitations not generally found in the overhead system, primarily because the in-the-floor system must be kept flush with the floor and may not lend itself to certain field conditions where floors, for example, change from partially concrete to wood, etc. Almost any kind of overhead building structure, whether of wood or steel construction, will be adequate to support the I-beam track of the overhead dragline system, as the direct loads are carried on the floor. The components of force due to towing will resolve themselves into a straight-line chain pull.

Some practical considerations toward selection of either the in-the-floor or overhead dragline are as follows:

(*a*) Costs of installation are about equal between the two systems, provided the in-the-floor unit is installed in a prepared trench.

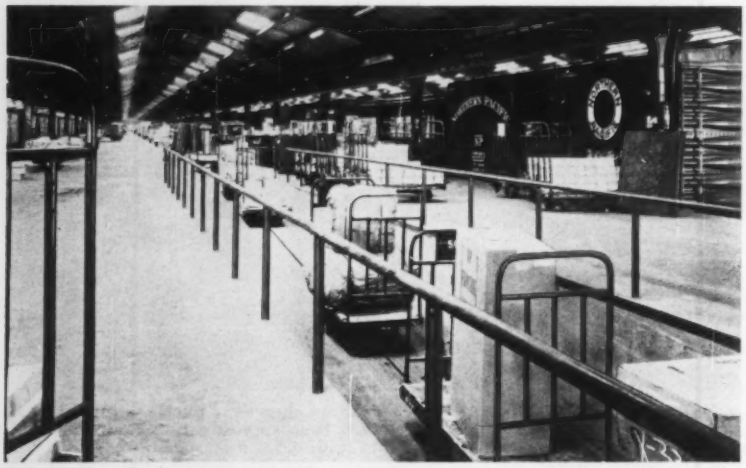
(*b*) Obviously, there are no physical interferences with the in-the-floor system, whereas if fork-lift trucks are used in conjunction with the overhead dragline, interferences may result.

(*c*) Some type of mast or chain-sling attachment is required on the trucks for connection with the conveyer in overhead systems, which is added expense. Generally, however, the overhead system is less expensive in initial cost than a comparable in-the-floor type dragline.

(*d*) Provision for "clean out" of the in-the-floor track dragline system is conscientiously engineered into the system and is extremely effective. Over-all accessibility to the overhead system is inherently one of its features, requiring no clean-out provisions.

(*e*) Planning for future extension of the in-the-floor dragline should be made prior to the time of initial conveyer installation, by designing extra pull and horsepower into the drive unit, and by providing easy connection access to the track at the points of future extension.

(*f*) Attachment of trucks to either system, judged from the operator's convenience, lies in favor of the in-the-floor system, wherein the operator simply drops the pin into the slot for engagement with the next oncoming pusher attachment.



**Center transfer platform at freight house No. 9, Burlington Railroad, Cicero, Ill. This conveyer (No. 2) also serves outbound house.**

### Education

**Teaching Machine Design for Modern Industry,** by L. G. Gitzendanner, Mem. ASME, General Electric Company, Schenectady, N. Y. 1956 ASME Semi-Annual Meeting paper No. 56—SA-67 (multilithographed; available to April 1, 1957).

CERTAIN techniques and methods are suggested which might be included in the college machine-design course to better prepare students for industry. The substitution of industrial-type problem situations for present academic problems is considered especially important not only

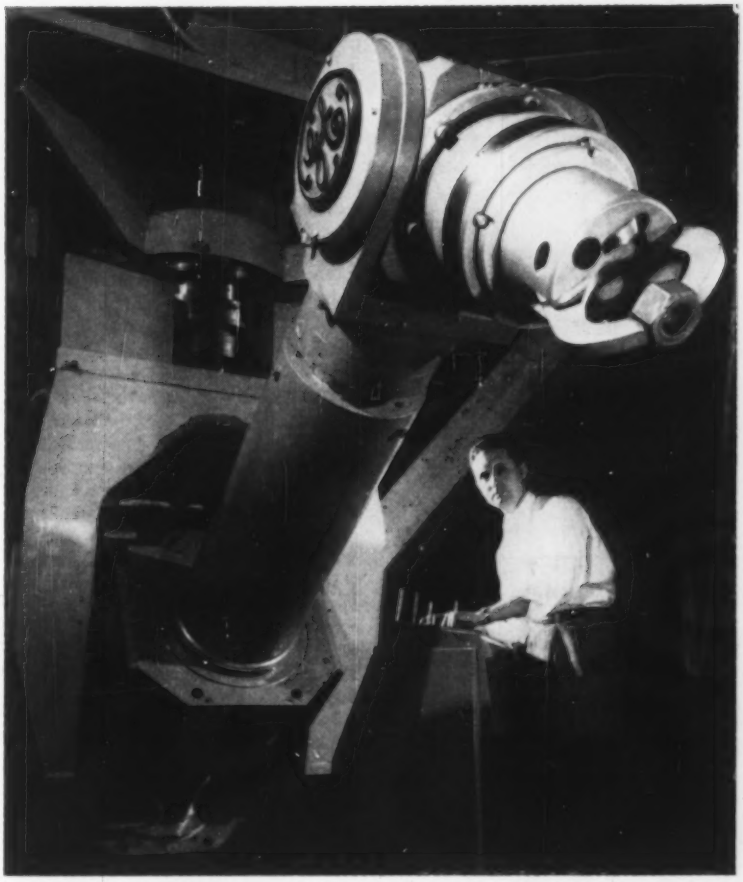
because it presents experience in a different type of problem solving, but also because it opens a natural approach to teaching such attitudes as the creative approach and proper appreciation and integration of material from many courses.

In the typical academic problem, the method to be used is indicated by the subject matter currently being taught. The assumptions, if any, are all stated, and the values of all pertinent parameters are given. Much of the opportunity for using imagination and ingenuity is lost. In the typical industrial problem, on the other hand, the problem statement is seldom clear. Data available are generally incomplete or are in very general and broad terms. At the same time, extraneous and irrelevant data may be present. Assumptions are a matter of engineering judgment. Method of solving is a matter of choice and involves considering such factors as accuracy needed, time available, and economics.

One area suggested for re-evaluation is the teaching of kinematics. In many colleges, kinematics is taught primarily in terms of graphical solutions only, and a considerable amount of time is spent learning and employing drafting techniques. Industry does not normally require engineers to do their own typing or drafting. Since kinematics problems can also be solved by analytical means and the generation of desired motions can be accomplished by a variety of methods, it is suggested that a more stimulating and more useful course could be organized by putting more of the emphasis on the learning of basic devices or mechanisms and their properties than by putting so much on a single method of solution.

Another area worth exploring is the problem of appreciating limitations. This is closely allied to the problem of selecting a device or mechanism. Kinematically, a design may be feasible. But the effects of dynamic forces, of deflection in stressed numbers, of thermal expansion, of clearances, tolerances, and of wear may be overlooked. Consideration of such factors as well as just the ideal kinematic considerations would help avoid many foolish or defective designs.

Perhaps one of the most important concepts that could be taught is the consideration of proportions. Past successful, or even unsuccessful, designs can be of tremendous help in creating new designs. Actually, considerable use is made of past experience or observation and proportions, but students are often taught to avoid such solutions; each problem is a new one to be solved without relation to others. But students should be instructed that proportions can be useful to them.



**Remotely controlled manipulator designed for atomic work. The design of the human arm was a valuable guide in engineering this mechanical arm.**

As an example of the use of proportions as a general guide only, consideration of the proportions of the human arm was of considerable benefit in designing a large remotely controlled manipulator, or mechanical arm, for atomic work. The mechanical arm had to be much larger and stronger than a human arm and had to work in an environment intolerable to human existence, but the design of the human arm was a valuable guide.

## Production Engineering

**Analysis of Manufacturing Costs Relative to Product Design,** by Lad J. Bayer, Mem. ASME, The Warner & Swasey Company, Cleveland, Ohio. 1956 ASME Semi-Annual Meeting paper No. 56—SA-9 (multilithographed; available to April 1, 1957).

This paper presents a set of charts plotting variables of quality against variables of cost for the purpose of illustrating how cost patterns may be related to industrial quality standards in product design. The charts trace cost patterns in relation to surface-roughness values, depths of drilled holes, tolerances and surface-roughness values in planing and face-milling operations, dimensional tolerances and surface roughness in cylindrical and internal grinding, in-feed and through-feed values for grinding, and dimensional tolerances for rotary grinding.

One of these charts is shown here. This chart was prepared to illustrate the cost behavior of one frequently occurring element of design, namely drilled holes. From the chart it is readily apparent that deep holes are expensive. Beyond the depth of three times the diameter, the cost rises more rapidly than equal increments of depth. The dotted line is shown merely to highlight the accelerated cost. Only standard drilling facilities were covered by the data. Special

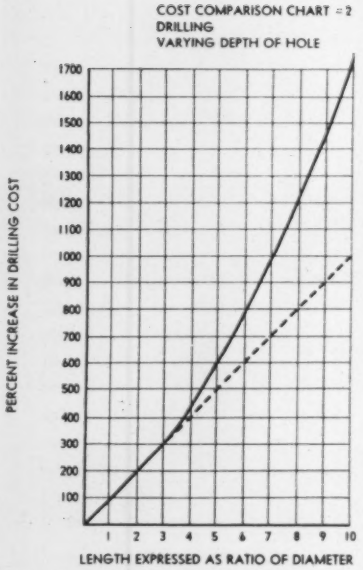



**Chart showing the cost behavior of drilled holes**

oil-hole drills or special trepanning tools would reflect cost patterns at variance with this chart. Such tools and supporting facilities are costly, however, and their use would have to be justified through amortization requiring prolonged product-design life and quantity production.

The charts illustrated indicate the natural tendency for cost and quality to behave as directly proportional variables. The principles employed in plotting these charts are considered applicable to any manufacturing organization. Their adoption merely requires the creation of charts conforming to the needs of the plant in question; the ease with which this can be accomplished by any manufacturing organization will be determined by the degree of standardization and availability of corresponding industrial-engineering data. Their application should result in manufacturing cost control during the early stages of design formulation and reduction of the time period between design development and ultimate production.

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**The H-Bomb and Industry Defense,** by V. L. Couch, Federal Civil Defense Administration, Battle Creek, Mich. 1956 ASME Semi-Annual Meeting paper No. **56—SA-3** (multilithographed; available to April 1, 1957).

Basic steps are outlined in this paper for the organization and operation of a civil-defense plan of self-help or self-protection against air attack within an industrial or commercial establishment. While the details must of necessity vary from plant to plant, the essential principles are listed as the following:

1 In each plant there must be effective civil-defense leadership. The responsibility for providing this leadership is in the hands of the owners and managers of the plants. The managers, therefore, should designate a person in charge of this activity—a plant civil-defense co-ordinator. He must be an individual who has executive ability, an individual in whom both management and employees can place their trust, an individual who, in time of disaster, can take complete charge of the situation.

2 The plant civil-defense co-ordinator will need some support and assistance in getting the job done in the plant. A good way to provide this assistance is through the establishment of an employee-management committee, if one does not already exist. If a labor-management committee is already functioning in the plant it can serve to stimulate the interests of employees in self-help or self-protection.

3 Make a survey of the plant buildings and the shelter requirements. Any area selected as potential shelter should be in the center or core of the building, away from exposure to the outside. Areas selected should be in a part of the building that is structurally compact, with a close spacing of columns and short-span beams. The area should be out of direct line with doors, windows, and hallways exposed to the outside. Walls and doors surrounding the areas should be free of glass. There should be at least one interior stairway, that is, one not adjoining an outer wall. The areas should contain no furnaces or boilers and no large steam, water, or gas pipes. The ceiling should not be of the hung or suspended type or have heavy lighting fixtures or plaster ornaments. The area should be free as possible of furniture, stored merchandise, and equipment of any kind. An area should not be selected if safes, banks of filing cabinets, or heavy machinery are on the floor above.

4 Select, train, and assign emergency protection personnel. These include wardens, police, firemen, engineering and rescue workers, medical and welfare workers.

5 Make a floor plan showing branch control rooms, first-aid station or cabinets, fire extinguishers, elevators and stairs, emergency lights and exits, and a general traffic plan within the plant.

6 Post directional and other information signs, including evacuation instructions in offices, meeting rooms, and other places of assembly.

7 Provide emergency supplies in shelter areas, such as first-aid kits, emergency water supplies, and emergency lighting.

In addition to these in-plant protective measures, industry should plan for continuity of management after attack, protection of vital records and documents, emergency repairs and restorations, deconcentration of production, and industrial dispersion. The establishment of industrial mutual-aid associations which provide for joint defense action of a group of plants and for the pooled use of emergency equipment and services is also recommended.

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**Some Experiments on the Influence of Various Factors on Drill Performance,** by D. F. Galloway, Production Engineering Research Association of Great Britain, Leicestershire, Eng. 1956 ASME Semi-Annual Meeting paper No. **56—SA-18** (in type; to be published in Trans. ASME; available to April 1, 1957).

Experiments are described as part of a series of investigations to obtain basic data needed for improving drilling techniques in a number of engineering factories. The main criteria of drill performance, and some of the principal factors which influence performance are discussed. Special attention is given to drill shape, and particularly to those elements, such as relief angle, point angle, relative lip height, etc., which can be controlled by the drill user.

Some of the conclusions reached are these: (1) Medium-duration life tests under carefully controlled conditions provide a valid indication of the practical effects of variations in drill shape; (2) point angle has a marked effect on drill life, the optimum point angle varying from material to material; (3) there is an optimum value of relief angle, although the differences from material to material are less marked than those for point angle; (4) drill life may be improved by a method of point thinning providing greater clearance near the corners of the chisel edge; (5) drill life is substantially reduced by large relative lip height; (6) reducing the point angle of the drill generally lowers the thrust and raises the torque; (7) within practical limits, relief angle has little effect on the drilling forces; (8) an increase in helix angle generally lowers the torque and thrust in drilling; (9) the thrust of thick-web drills can be reduced by suitable point thinning; (10) under unfavorable conditions of machine rigidity, drill breakthrough may be accompanied by large increases in drilling torque and specific

loading at the cutting edges, and drill failure or breakage may result; (11) the chatter vibrations which sometimes occur during drilling appear to be mainly self-generative in origin; (12) hole size is markedly dependent on the symmetry of the drill point; and (13) hole alignment is dependent on drill deflection at the commencement of drilling and certain types of errors in the machine.

The theory of self-regenerative vibration in drilling is discussed, and theories are developed to explain inaccuracies in hole size and alignment. The paper includes test results which tend to support these theories. Reference is made to those considerations of drill geometry and specification which entered into the investigations.

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**Production Surfacing of Aluminized Engine Valves,** by J. A. Newton and M. D. Braid, Thompson Products, Inc., Cleveland, Ohio. 1956 ASME Semi-Annual Meeting paper No. **56—SA-35** (multilithographed; available to April 1, 1957).

THE problems involved in experimentation and research to find an economical way of applying a protective aluminum-iron alloy layer to the working faces of internal-combustion-engine valves are discussed in this paper. Such a coating extends the life of these valves from two to three times that of a conventional valve made of the same material. Increased oxidation resistance provided by the alloy layer results primarily from the formation of aluminum and complex iron-aluminum oxides that provide a protective film which inhibits further attack on the base metal.

The initial high cost of mass producing the aluminized valves by the General Motors Aldip process brought about the method of metallizing and induction heating for higher standards of quality and reduction in cost while retaining the benefits of the aluminum coating. The technique now being employed for mass producing aluminum-coated engine valves puts this new development within the reach of all engine builders.

After various uneconomical trial arrangements involving heating the valve in a fluxing salt, dipping it in molten aluminum, and passing it through an air blast to remove the excess, a final-process design was evolved that produces quality parts on an economical basis. It consists of degreasing, induction preheating to 400 F, aluminum spraying, induction posthéating to 1400 F to form the alloy film, and final inspection.

Since the final induction heating affects the entire valve head, the high temperature causes a slight distortion. In answer to this problem, the authors plan the use of radio-frequency heating in the last stage of the process. By this method only the outside periphery of the valve will be heated, and distortion will therefore be kept to a minimum.

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**Steps Toward More Creative Production Engineering,** by W. P. Smith, Michigan State University, East Lansing, Mich. 1956 ASME Semi-Annual Meeting paper No. **56—SA-49** (multilithographed; available to April 1, 1957).

THIS paper discusses the possible solution production engineering may hold to the problem of manufacturing cost in modern mass production. As our economy expands and the need for "mass-produced" items grows, the challenge to reduce manufacturing costs becomes increasingly great. To meet this demand requires production engineering of a degree seldom seen today.

The author advocates the gathering of production-engineering functions under one head in a plant, instead of leaving them divided, as at present, under the jurisdiction of many departments. The production-engineering department would then be responsible for all work involved in specifying the methods of manufacturing the product. It would perform the following activities: (1) Process engineering and routing, (2) methods engineering and motion study, (3) tool design, (4) materials-handling-system design, (5) plant-layout design, (6) time study and work measurement, (7) machinery-replacement analysis, (8) process and methods research and development.

In addition, the author set forth five roadblocks standing in the way of the production engineer: organizational conflicts and inefficiencies; the need for better production-engineering specifications; the need for creative development of alternative production plans and processes; the need for better analytical tools to study the behavior of production plans and processes; and the need for development and training of production-engineering personnel of high caliber.

The production engineering function as it is generally known today is a relatively recent addition to the structure of industrial organizations.

The scientific method must become a partner with production engineering, and the most advanced tools must be brought to bear on production-engineering problems. Finally, men of the highest ability must be encouraged to enter this area and then be trained to perform a real engineering job.

## Heat Transfer

**Study of Heat Transfer to Liquid Nitrogen,** by L. E. Dean, Aerojet-General Corporation, Sacramento, Calif., and L. M. Thompson, Bell Aircraft Corporation, Buffalo, N. Y. 1956 ASME Semi-Annual Meeting paper No. **56—SA-4** (multilithographed; available to April 1, 1957).

THIS paper describes an experimental investigation of forced-convection heat transfer to liquid nitrogen. A description of the test apparatus and test procedure used to obtain experimental data is included. Data are presented for heat transfer to liquid nitrogen flowing at 40 fps through an annular passage under nonboiling, nucleate-boiling, and film-boiling conditions at pressures above and below critical.

Normal forced-convection heat transfer occurs when heat is transferred from a hot surface to a liquid without a phase change occurring at the interface. In this investigation normal forced convection continued until the wall temperature exceeded the saturation temperature of the coolant (—250 F at 300 psia) or the critical temperature of the coolant (—233 F above critical pressures).

A nonboiling liquid-film heat-transfer coefficient of 0.0136 Btu/in.$^2$ sec deg F ± 7 per cent was obtained flowing liquid nitrogen through an annulus having an equivalent diameter of 0.0115 ft at a velocity of 40 fps (Reynolds number of 200,000).

Nucleate boiling occurs in the liquid layer adjacent to the heated surface when this surface exceeds the saturation temperature of the coolant, causing bubble formation at the heated surface. The bubbles thus formed are not important carriers for the heat-transfer process; however, by acting as agitators, they increase the rate of heat transfer from the wall to the liquid. In nucleate boiling the fluid velocity has only a small effect upon the heat transfer since turbulence caused by the bubble action is large compared with the turbulent effect of the bulk fluid velocity. The driving force in the nucleate-boiling region is the difference between the heater-tube wall temperature and the saturation temperature.

The study of the heat-transfer phenomena in the supercritical regions is one of the least developed regions of all forms of heat transfer. A graphical comparison is shown of the heat-transfer processes at pressures below and above critical.

Nonboiling heat transfer occurs at pressures below the critical, in the region where the heating-surface temperature is below the saturation temperature of the coolant (*A* to *B*). See illustration.

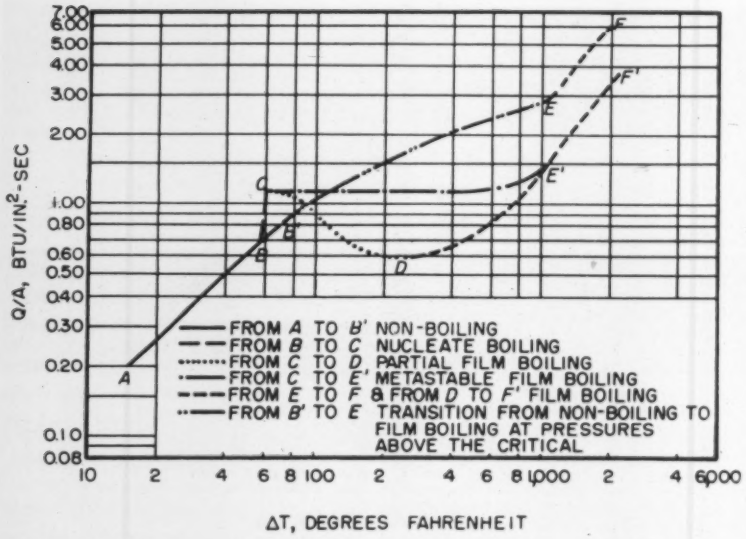


**Chart of typical heat-transfer processes at both subcritical and supercritical pressures**

When the saturation temperature is exceeded, nucleate boiling occurs with small bubbles forming at nuclei along the heated surface. The increased turbulence, caused by this bubble formation, results in increased heat flux with small increase in wall temperature (*B* to *C*). At the upper limit of nucleate boiling (*C*) these nucleate bubbles begin to coalesce. When operating in the transition region (*C* to *E*), the heat-transfer process is dependent upon the type of equipment employed in conducting the tests.

The apparatus used in this investigation consisted of an electrical-resistance heater in which all generated heat is transferred directly into the coolant. With additional power input beyond point C, the increased thermal resistance due to the vapor film caused the heating-surface temperature to rise sharply. This transition region is metastable film boiling (*C* to *E*). The wall temperatures during this transition phase may exceed the stress limit of the tube or reach the melting point of the metal causing failure. It is possible under certain conditions of velocity and pressure to attain stable film boiling (*E'* to *F'*).

The mechanism of heat transfer is quite different when the process is accomplished in regions above the critical. The nonboiling condition exists at heating-surface temperature below the critical temperature of the coolant (*A* to *B'*).

Beyond this point a gradual transition commences caused by the buildup of a boundary layer having a high thermal resistance. This transition from nonboiling to stable film boiling (*B'* to *E*) is a gradual process, unlike subcritical conditions where this transition is unstable. From point *E* to *F* a condition of stable film boiling exists until excessive wall temperature causes failure. A 100 per cent higher film-boiling heat-transfer coefficient may be obtained at supercritical pressures than at subcritical pressures under similar flow conditions.

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**Turboconditioning Systems With Vapor Compression Cycles,** by J. P. Barger, Assoc. Mem. ASME, and W. M. Rohsenow, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass., and K. M. Treadwell, Assoc. Mem. ASME, Westinghouse Electric Corporation, Pittsburgh, Pa. 1956 ASME Semi-Annual Meeting paper No. 56—SA-7 (multilithographed; available to April 1, 1957).

THIS paper reports the results of a comprehensive study of the possible configurations and relative performances of turboconditioning systems which combine vapor compression and air cycles for cooling supersonic aircraft. Numerical values for the performance of eight different system arrangements at Mach numbers 2, 3, and 4 are presented.

The systems divide into four major groups according, first, to whether the cabin air is "bled" (*B*) from the existing jet-engine compressor or whether a new diffuser is added to the airplane to provide this air by ramming (*R*) effect; and, second, according to whether the sink-air stream is expanded (*E*) in a turbine or not (*N*) before it reaches the vapor condenser. Component arrangements yielding optimum performances are developed partly by simple thermodynamic reasoning; for those systems where no choice can be made on this basis, calculations reveal systems exhibiting superior performance.

The results clearly demonstrate the increasing difficulty of cooling as speed increases, pointing to the great advantage of regeneration, especially at higher Mach numbers.

Changing the cabin-air compression ratio affects both the cooling effect and the system work, influencing the latter mainly through the vapor cycle. Increasing the compression ratio in systems without an air-to-air heat exchanger between the compressor and the evaporator raises the heat flow to the evaporator. This occurs at so great a rate that the system work rises rapidly, the cooling effect falls, and the coefficient of performance (c.o.p.) decreases steeply.

On the other hand, with an air-to-air heat exchanger interposed between the compressor and the evaporator (a much more efficient arrangement as regards economy of sink-air utilization), the evaporator load tends not to rise as fast with increasing cabin-air compression ratio because the heat exchanger absorbs a large fraction of the increase. This causes the optimum compression ratio to shift to a value usually greater than 10 but less than 20 for systems which include the pre-evaporator heat exchanger. At higher compression ratios, the temperature rise of the air in the compressor becomes so large that the evaporator heat transfer increases materially, causing a large decrease in system performance because of a sizable increase in system work.

Because of the rise in stagnation and re-expanded sink-air temperatures with Mach number, both the minimum and the optimum vapor-condenser temperatures increase, causing the vapor-cycle evaporator-condenser temperature difference to increase. Rising vapor-compressor work and sink-air flow cause c.o.p. to decrease rapidly with increasing Mach number.

In changing altitude between 40,000 and 100,000 ft at a fixed Mach number, the ambient and stagnation temperatures remain constant. At lower Mach numbers and higher altitudes, cabin pressure requirements dictate higher cabin-air compression ratios. The higher ratios do not materially affect system performance unless the system fails to include a pre-evaporator air-to-air heat exchanger.

The system c.o.p. calculated in this study yields results close to reality for all (E) systems with a secondary-air expansion turbine. When this turbine is eliminated, as in (N) systems, a backward-directed nozzle should be sub-

stituted to recover thrust from expansion of the sink air. The performance of (N) systems approximates that of (E) systems when the nozzle thrust is taken into account.

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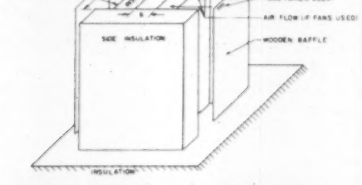
**Tests of Free Convection in a Partially Enclosed Space Between Two Heated Vertical Plates,** by Robert Siegel, Assoc. Mem. ASME, National Advisory Committee for Aeronautics, Cleveland, Ohio, and R. H. Norris, Mem. ASME, General Electric Company, Schenectady, N. Y. 1956 ASME Semi-Annual Meeting paper No. **56—SA-5** (in type; to be published in Trans. ASME; available to April 1, 1957)

THE free-convection heat-transfer coefficients were measured, as a function of spacing, for two parallel, electrically heated, vertical plates. The top of the rectangular space between the plates was left open, and during most of the tests the bottom and sides were closed. The heat input per unit area was substantially uniform, and the Grashof number, based on plate height, was of the order of $10^{10}$. The results demonstrate how the surface-temperature rise increases, or the local Nusselt number decreases, as either of the cross-section dimensions of the free-convection space is reduced. This decrease in Nusselt number is less rapid than was expected from purely two-dimensional flow considerations. This is ascribed to the effect of an asymmetrical flow pattern observed in the space. In some cases, a periodic reversal of this asymmetrical flow also was observed. When the space between plates was opened sufficiently at the bottom, the results were reasonably consistent with the correlation proposed by Jakob for a single vertical plate with a turbulent boundary layer; these results were almost independent of spacing between the heated surfaces down to the minimum spacing tested.

The basic configuration of the test surfaces is shown schematically. To help minimize stray heat losses each of the test surfaces was backed by thermal insulation and an independently heated guard plate. The heat input to the guard plate was adjusted to keep its average temperature approximately equal to the average temperature of the test plate. Six layers of aluminum-foil insulation were provided between the test and guard plates to reduce to a very low value any heat flow resulting from the unavoidable small local inequalities of temperature between the two plates.

A horizontal air flow was provided across the tops of the heated panels in certain of the tests by three axial-flow fans. Although the resulting air flow was somewhat nonuniform and rather turbulent, it served to permit evaluation of the sensitivity of the test-plate temperatures to such a horizontal air stream, with a minimum expense for provision of the flow. The average velocity of this flow was measured with a velometer.




**Schematic arrangement of surfaces for free-convection tests**

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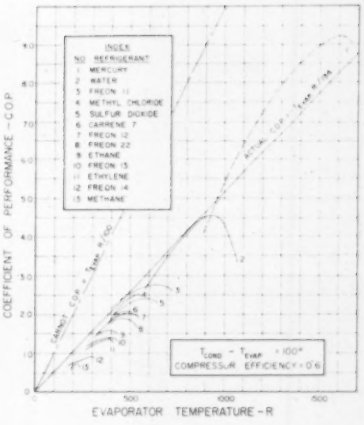
**A Comparison of Refrigerants When Used in Vapor Compression Cycles Over an Extended Temperature Range,** by J. P. Barger, Assoc. Mem. ASME, W. M. Rohsenow, Mem. ASME, and K. M. Treadwell, Massachusetts Institute of Technology, Cambridge, Mass. 1956 ASME Semi-Annual Meeting paper No. **56—SA-6** (in type; to be published in Trans. ASME; available to April 1, 1957).

THIS paper gives methods for selecting the refrigerant, or series combination of refrigerants, which exhibits optimum thermodynamic performance when employed in vapor cycles operating between arbitrarily selected temperatures.

Coefficients of performance (c.o.p.) are plotted in the graph for 13 different refrigerants as well as the corresponding Carnot c.o.p, each for cycles with condenser temperatures 100 F higher than evaporator temperatures, and compresser efficiencies of 0.60. Inspection of the graph reveals these effects: (1) Refrigerants employed in the same temperature range vary in performance for equal component efficiencies, allowing selection of a thermodynamically optimum refrigerant for that range; (2) the highest values of the actual c.o.p. are consistently slightly greater than half of the values of Carnot c.o.p. throughout the entire temperature range considered; (3) the working temperature range of each refrigerant appears to decrease with decreasing absolute temperature; (4) the c.o.p. of a 100-F cycle exhibits a definite optimum point, falling off rapidly as the condenser temperature increases toward the refrigerant critical temperature, more gradually as the evaporator temperature decreases below the optimum point; and (5) all c.o.p. tend to blend together on the same line as the difference between the refrigerant critical temperature and the cycle evaporator temperature increases




**Coefficients of performance for various refrigerants versus evaporator temperature**

for each refrigerant. However, in every case, this region for each refrigerant is accompanied by extremely small pressures and large vapor specific volumes, precluding use in this range.

The selection of a thermodynamically optimum refrigerant in a particular temperature range can be accomplished as follows: (*a*) The range where refrigerant absolute pressure exceeds atmospheric pressure and refrigerant specific volume is lowest corresponds to the "hook" or the maximum c.o.p. part of each curve; (*b*) selecting the appropriate temperature range, observe which refrigerants exhibit the highest c.o.p. in this range. Select the refrigerant which exhibits the generally highest curve; and (*c*) where two or more refrigerants appear extremely close in performance, calculations for each refrigerant in the particular cycle desired will reveal which exhibits better performance.

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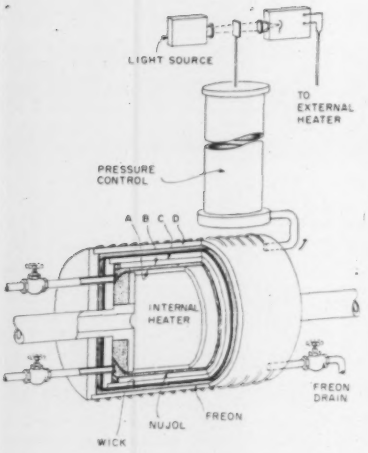
**A Novel Method of Obtaining an Isothermal Surface for Steady-State and Transient Conditions,** by G. N. Hatsopoulos and J. Kaye, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1956 ASME Semi-Annual Meeting paper No. **56—SA-13** (multilithographed; available to April 1, 1957).

A NOVEL method of obtaining an isothermal surface based on the thermodynamic properties of a two-phase mixture of liquid and vapor is presented. A wick material which absorbs the liquid phase by capillary action is used to produce a large interfacial area of liquid and vapor of a single component substance over a cylindrical geometry and thus maintain the constancy of temperature of this area as long as the pressure of the two-phase mixture is maintained constant.




**Model of a simulated gyro, consisting of four concentric aluminum cylinders, A, B, C, and D**

Such an isothermal surface was designed and constructed for a model of a simulated gyro of high precision. The behavior of this isothermal surface actuated by the wick-liquid-vapor control system was tested and compared with the behavior of a conventional control system using an external temperature-sensing device.

The results indicate that the wick-liquid-vapor control system is probably capable of producing an isothermal surface in a real gyro which will have a constancy of temperature within 0.05 F, if fluids of the desired characteristics are used. Freon 113 yielded an average deviation from the mean temperature of about 0.3 F for the isothermal surface for both steady-state and transient effects of blast cooling and of sudden changes in value of internal-heater power. However, use of water as the fluid in contact with the wick would significantly reduce the value of the average deviation found for Freon 113.

Comparison of the wick-liquid-vapor control system with a conventional control system showed that both are satisfactory for a real gyro for steady-state conditions of operation. But when a blast of cooling air is suddenly directed over the gyro, the maximum change in the average temperature of the isothermal surface is 20 times as large as that for a conventional system. Likewise, if the internal-heater power is suddenly increased from 7 to 22 watts, the maximum change in the average temperature of the isothermal surface is about 25 times as large as that for the wick-liquid-vapor system.

It is probable that a simple wick-liquid-vapor control system can be designed for the particular geometry of a precision gyro or for the odd-shaped geometry of many pieces of electronic equipment and that such a control system can maintain an isothermal surface constant in temperature with 0.05 F. Furthermore, if a simple pressure-control device is devised which is independent of ambient conditions, then this wick-liquid-vapor control system can be made highly insensitive to ambient conditions of temperature, pressure, air velocity, acceleration of gravity, and direction of the gravitational field.

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**Influence of Through-Metal on Heat Transfer Through Aircraft-Structural-Sandwich Panels,** by J. R. Woolf, Mem. ASME, and L. R. Scott, Assoc. Mem. ASME, General Dynamics Corporation, Fort Worth, Texas. 1956 ASME Semi-Annual Meeting paper No. **56—SA-23** (multilithographed; available to April 1, 1957).

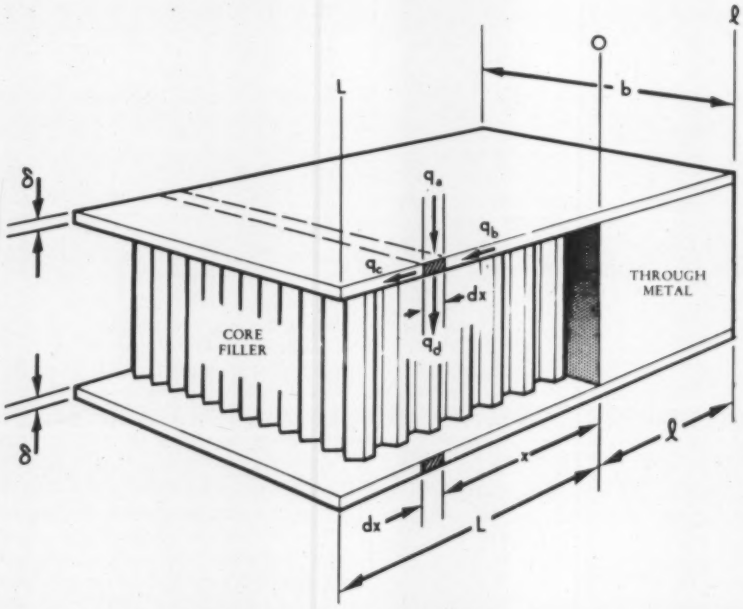
Analytical inspection of a sandwich-type structural panel indicates that the fin effect of the inner and outer skins and the through-metal is of great importance in determining the heat-transfer characteristics. An analytical derivation is presented for the over-all conductance of a sandwich panel having internal through-metal slugs with metal skins of the same thickness on both sides. The derivation is for a basic configuration, and the final equations must be modified for application to different configurations. Theory is extended to include a specific panel and results are obtained for a test specimen in which the effect of special splice slugs between two adjoining sections is considered.

The two-dimensional representation of the sandwich panel consists of metal skins which are filled with materials such as fiberglas or metal honeycomb, balsa wood, and foamed-in-place plastics. It is usually necessary to have slugs of through-metal in these sandwiches to improve the strength and to form a base for attachment of internal spars, webs, and stringers.

The case at hand is one in which the film coefficients on either side may be quite different, such as with a high-speed airstream on one side and fuel, fuel vapor, or relatively still compartment air on the other side.

An analytical solution which would apply to other configurations is made for the following assumed conditions:

(1) skin thicknesses the same on each side; (2) uniform and constant fluid temperature and film coefficient on either side; (3) homogeneous and isotropic materials, the conductivity of which is independent of temperature; (4) radiation effects absent; (5) no lateral conduction in the core filler or through-metal; and (6) heat transfer from one metal skin through the insulation to the other skin approximated by use of a constant $\Delta t$ mean.




**Two-dimensional representation of sandwich-panel-type of structural configuration**

An experimental program was initiated to determine the conductance through sandwich panels. When the program was begun it was designed to yield experimental values for a certain type panel. However, as the theoretical considerations progressed, it became apparent that it would be impossible to test all of the configurations which would be used in aircraft—different skins, thicknesses and materials, different fillers, and different geometrical spacing. The experimental program then became a check for the theoretical program.

The difference between experiment and theory for the specimen coefficient (fluid-to-fluid) $V_0$ is 7.8 per cent average with a maximum deviation of 10.6 per cent over the experimental range. No provision for measuring the cold-side film coefficient was made when the apparatus was designed. The average difference between experiment and theory for a cold-side film coefficient of 35 Btu/hr sq ft deg F is only 0.6 per cent with a maximum deviation of 4.9 per cent. The cold-side (water) film coefficient varied from test to test.

For the range of conditions investigated, the primary variables are the slug half-width and the skin thickness. Cross plotting of the data indicates that changing the slug width has a greater effect on $U_0$ than changing the skin thickness. Doubling the slug width results in an increase in $U_0$ roughly two times that obtained by doubling the skin thickness. The main contributor in all cases is the fin effect caused by the skins and through-metal, this being in the order of 50 per cent of the total heat gain through the panel.

With a hot-side coefficient of 10 Btu per hr sq ft deg F and a cold-side coefficient of 25 Btu per hr sq ft deg F, which might simulate high-altitude supersonic flight, the results indicate an over-all coefficient of 4.34 Btu per hr sq ft deg F for the test panel. Comparison of this figure with the 7.14 Btu per hr sq ft deg F allowed by a conventional skin reveals that the test panel permits a heat-transfer rate about 40 per cent less than that through a solid skin. However, the test panel allows nearly three times the heat gain as the same panel with no through-metal slugs.

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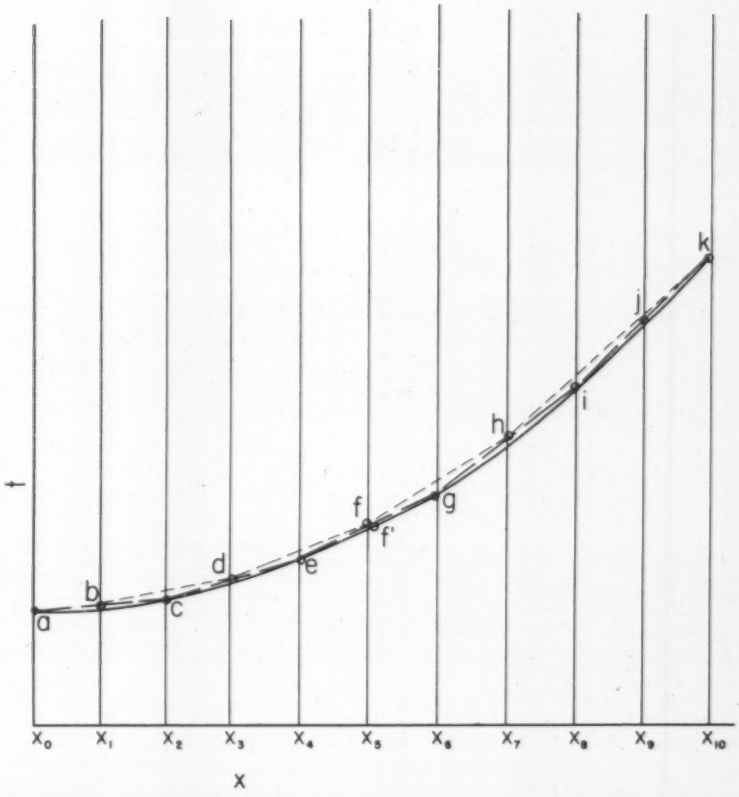
**A Mechanical Computing Device for the Analysis of One-Dimensional Transient Heat-Conduction Problems,** by Warren E. Howland, E. A. Trabant, and G. A. Hawkins, Mem. ASME, Purdue University, Lafayette, Ind. 1956 ASME Semi-Annual Meeting paper No. **56—SA-27** (multilithographed; to be published in Trans. ASME; available to April 1, 1957).




**The Hackemann idea is illustrated by the diagram. It was designed for use in the solution of one-dimensional transient heat-conduction problems.**

This paper covers an extension of the Hackemann idea to the solution when the thermophysical properties vary with temperature. Dr. P. Hackemann designed and constructed a mechanical device for use in the solution of one-dimensional transient heat-conduction problems. The device replaces the laborious task of line drawing required in the Binder-Schmidt graphical method by a semiautomatic machine operation.

Before introducing the suggested mechanical computer, a brief discussion of the Binder-Schmidt graphical method for solving one-dimensional transient heat-flow problems is given. The Binder-Schmidt procedure is basically a graphical solution of a finite-difference equation which replaces the basic partial differential equation used to express the transient-conduction heat transfer in the system.

The Hackemann idea is illustrated by the diagram. An elastic string could be made to take successive positions of the temperature-distribution curve if it were operated in the following manner: First, let it be stretched to take the positions *a-c-e-g-i-k*. Then let it be held at the positions *a-b-d-f-h-j-k* and released at points *c*, *e*, *g*, *i*. Then let it be clamped in these new positions where the string crosses the vertical lines above the points *c*, *e*, *g*, *i*, etc. The string will always be held at *a* and *k* but alternately on the solid vertical lines. A mechanism that would alternately clamp the string along every other vertical line and then on the others was constructed by Dr. Hackemann.

The possible use of an elastic-string computer in the study of temperature distributions in composite walls is considered in this paper.

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**A Systematic Study of Air Cycles for Aircraft-Cooling Applications,** by L. R. Stevens, Jr., General Electric Company, West Lynn, Mass. 1956 ASME Semi-Annual Meeting paper No. **56—SA-11** (multilithographed; available to April 1, 1957).

Various types of air-cycle cooling systems are compared thermodynami-

cally. The most suitable of these are examined to determine the relative extent of their applicability over a range of aircraft operating conditions.

Certain "families" of systems are investigated. Such a family is that which consists of an alternating series of bleed-air compressors and ram-cooled heat exchangers followed by a turbine just upstream of the cabin. The simplest system in this category is III-3, the so-called "bleed-blower," which consists, in order, of a compressor, a heat exchanger, and a turbine in the bleed-air line. Next in order of complexity comes System IV-3, commonly known as the "bootstrap," which is constructed by merely adding a heat exchanger ahead of the compressor in the bleed-blower system. Systems V-5 and VI-4 are two others in this general progression for which some graphical results were obtained. Although these systems perform the function of decreasing the entropy of the bleed air before expanding it to cabin pressure, they rely on unexpanded ram air alone as a heat sink.

Another, more loosely defined, relationship involves those systems in which a ram-air turbine is used to take advantage of the ram-to-ambient pressure ratio, thereby reducing the heat-sink temperature. Of the arrangements which have merit, the simplest is System III-4, which consists of a ram-air turbine, a heat exchanger, and a loading compressor, in that order, with bleed air being cooled during its passage through the other side of the heat exchanger.

Next in order of complexity is the reduced-ambient system (IV-1), which expands the bleed air through a turbine to cabin pressure after it leaves the heat exchanger. System IV-2 is still another type of four-component arrangement which makes use of ram-air expansion.

In general, the comparison of systems in a given complexity grouping consists merely of determining the best system for a representative spectrum of operating conditions. Systems IV-2 and IV-3 (the bootstrap system) afford a more instructive insight into the evolution of systems, since they represent two different variations of the basic bleed-blower arrangement. In the case of IV-3, the fourth component is a heat exchanger added upstream of the compressor in the bleed-air line, while System IV-2 has a turbine in the ram-air line.

Graphical results for these two systems indicate that IV-2 is always superior at extremely high flight speeds from a thermodynamic-performance standpoint. This superiority becomes more pronounced as the engine-pressure ratio decreases. Even for Mach numbers near one, System IV-2 shows an advantage for engine pressure ratios less than three-to-one. However, for more reasonable pressure ratios (such as ten-to-one), the bootstrap system (IV-3) performs better at subsonic and the lower supersonic plane speeds. At the flight conditions where System IV-2 is superior, the delivery temperature is still too high to make it attractive for practical applications.

The question at once arises as to the benefits to be achieved from combining the features of Systems IV-2 and IV-3. This is done in System V-1. Comparison of the performance for these three systems shows that V-1 yields rather remarkable gains. This again is illustrative of the fact that expanded ram-air heat sinks do not come into their own except in the more complex systems which are necessary to accommodate cooling requirements at extremely high flight speeds.

From the investigations, the following conclusions are summarized:

1 System III-3, the so-called bleed-blower, is the best of the systems having only three components, but its range of applicability is decidedly limited.

2 Of those systems involving four components, System IV-3, the bootstrap, is the best arrangement which does not make use of expanded air as a heat sink.

3 Of those four-component systems which do make use of expanded ram air, Systems IV-1 (reduced ambient) and IV-2 yield equivalent performance under some circumstances. For most of the usual operating conditions, however, System IV-1 is preferable.

4 System V-1 is the best of the systems studied which require five components.

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**A Survey of Possible Refrigerants for High-Temperature Application,** by J. Van Winkle, General Electric Company, Pittsfield, Mass. 1956 ASME Semi-Annual Meeting paper No. **56—SA-12** (multilithographed; available to April 1, 1957).

This refrigerant study is the result of a six-month survey of materials which could be used in a conventional vapor-cycle system operating at the high sink temperatures required in supersonic airframes. Since the operating conditions are so stringent, elements and mixtures of elements are considered as well as ionic and organic compounds.

Since cooling is not required when ambient temperatures are in the region of 65 F, the most stringent restriction on the refrigerant is that its vapor pressure be relatively low at high temperatures. This requirement is important because materials of construction are weakened at high temperatures.

The elements suitable for vapor-cycle refrigerants in the temperature range desired are mercury and the alkali metals. Phosphorus is eliminated because of its violent reaction with oxygen or air.

Mercury is found the most suitable of the elements because of its inertness and its extremely high critical temperature, which is above 2800 F. Considerable experience with mercury has been obtained in high-pressure steam plants.

The alkali metals, especially sodium, are used as heat-transfer fluids in nuclear-reactor cooling. Though operating information is not readily available, it is believed that they are utilized in the liquid state. The higher atomic-weight alkali metals (rubidium or cesium) could be used in a vapor cycle between the temperatures required. However, the alkali metals react violently with water and are quickly oxidized by air at room temperature.

Many compounds are used today as vapor-cycle refrigerants. Among these, the Freons (made by du Pont) are used at temperatures below 400 F, the Ukon Fluids (Union Carbide) are limited to use below 500 F, Arochlor (Monsanto) and S/V Heat Transfer Oil (Socony Vacuum) can be used up to 600 F, and Dowtherm (Dow Chemical) has application up to 650 or 700 F. Beyond this temperature all of these compounds begin to decompose at an appreciable rate. Even silicone oils decompose at an appreciable rate (in the presence of oxygen) at 750 F.

A compound recommended for use at high temperatures is polydifluoromethylene. Of nearly equal stability is a partially chlorinated, partially fluorinated polymethylene. The latter is Kel-F (M. W. Kellogg), a compound completely analogous to the Freons, only of higher molecular weight; it should be quite satisfactory for a high-temperature vapor-cycle refrigeration.

In addition to elements and compounds, alloys as a group are studied. No particular advantages are to be expected from an alloy as its thermodynamic properties should lie between the properties of the pure components. The eutectic alloy corresponding to the formula $K_2Na$, referred to as "NaK," is used as a liquid heat-transfer agent, especially in cooling atomic reactors. Existence of technology on use of "NaK" heat-transfer fluids militates in their favor.

Mixtures are also studied, but none of them are found suitable for use as a refrigerant.

In conclusion, the materials which can

be used as refrigerants in high-temperature vapor cycles are: elements—mercury and alkali metals; alloys—"NaK;" compounds—fluorinated-chlorinated hydrocarbons (Kel-F).

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**The Thermal Problems of High-Speed Flight and the General Electric Company's Aircraft-Cooling Program,** by J. W. Rizika, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1956 ASME Semi-Annual Meeting paper No. **56—SA-24** (multilithographed; available to April 1, 1957).

THIS paper reviews the basic cooling problems of high-speed flight. In particular, it discusses the objectives and presents some of the conclusions of the General Electric Company's aircraft-cooling program. Although security and company proprietary regulations present some restrictions, a number of significant conclusions are discussed. These are as follows:

1 Experience indicates that each particular aircraft-conditioning application requires a turboconditioner system especially designed for the conditions peculiar to that aircraft. Aircraft manufacturers appear unwilling to trade performance for immediate availability except in rare circumstances.

2 Turboconditioner "criteria," such as cooling loads and temperature levels, are established by the aircraft manufacturer—there is no categorical cooling load for any given type of aircraft for any specific aircraft-performance parameters. All that can be stated is that aircraft-cooling requirements (not including the engine) appear to be in the order of from 100,000 to 800,000 Btu per hr for the next ten-year period.

3 The aircraft-cooling load (not including the engine) is expected to remain relatively independent of the aircraft Mach number. It is expected that the total cooling load will be increasing in future aircraft but this will be due, primarily, to more complex weapons systems which contain additional accessories and power-producing devices. The aircraft personnel and equipment-cooling load will be approximately proportional to the heat generated by the personnel and equipment.

4 More complicated turboconditioning systems are necessary as the aircraft Mach number increases. The ram-air temperature rise is approximately proportional to the square of the Mach number.

5 Combined "refrigeration-auxiliary-power" packages which could supply the entire aircraft-cooling load and auxiliary hydraulic and electrical-power requirements appear to be more economical when considering the complete aircraft system-mission penalties for many future applications.

6 Air cycles, perhaps making use of expendable cooling media and regeneration, appear to be the most promising cooling systems for operational aircraft over the next ten-year period.

7 The use of expendable cooling media in conjunction with an air-cycle system affords larger cooling capacities and lower temperature levels.

8 If it is possible to make use of regeneration in an air-cycle system, vapor-cycle application has no merit. When regeneration is not available, however, vapor-cycle systems appear to be useful when either no pressurization is necessary or an external system is to supply the required pressurization. Even under these conditions, vapor-cycle applications are limited to condenser-evaporator temperature differentials below 150 F.

9 The absorption cycle may have potential merit for specific cooling applications; this depends, primarily, upon the temperature-level requirements and mission requirements of the aircraft. It appears, however, that this cycle has little application due to the attitude and acceleration requirements it would impose on an aircraft in order to function properly.

10 The utilization of fuel as a heat sink (particularly the latent heat of vaporization) has many advantages. This represents a large heat sink readily available—particularly at the most needed conditions of flight. Little or no performance penalty is necessary when fuel is the primary heat sink, since fuel must be carried in the aircraft for propulsion purposes.

11 The use of the heat capacity of the aircraft structure—thermal lag—appears limited to experimental craft of extremely short flight duration and ballistic-type missiles. It is of little use, if any, where the flight mission is long.

12 Radiative cooling of aircraft at altitudes up to 120,000 ft is not effective; it is overwhelmed by the magnitude of aerodynamic heating or cooling.

13 At the present time, thermoelectric cooling systems are inadequate for aircraft-cooling applications. Progress in thermoelectric cooling appears to depend, to a very large extent, on developments in the comparatively new field of semiconductors.

14 It is doubtful that the vortex tube will ever have any aircraft-cooling applications, except under rare circumstances. The efficiency of the vortex tube—about 20 per cent maximum—is much less than the efficiency of an expansion turbine operating under the same conditions.

15 Turboconditioner controls will probably create the greatest single problem in the design of future systems—particularly control systems concerned with combined "refrigeration-auxiliary-power" packages and where use is made of a fuel heat sink. Mechanical reliability and design simplicity will probably be a close second.

16 Analog and computer analyses afford tremendous time-savings in the more complex turboconditioner system analyses. Analog steady-state analyses may be carried out 100 times more rapidly than "human" analyses; similar statements may be made concerning transient analyses carried out on computers.

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**Generalized Optimal Heat-Exchanger Design,** by D. H. Fax, Assoc. Mem. ASME, Westinghouse Electric Corporation, Pittsburgh, Pa., and R. R. Mills, Jr., Assoc. Mem. ASME, The Johns Hopkins University, Baltimore, Md. 1956 ASME Semi-Annual Meeting paper No. **56—SA-19** (in type; to be published in Trans. ASME; available to April 1, 1957).

BASED on the use of Lagrangian multipliers, a generalized method for formulating the problem of the design of an optimum heat exchanger is developed. The method is particularly useful in those problems where several variables are to be optimized simultaneously. In the paper, the method is exemplified by the solution of three problems in gas-turbine regenerator design, at least two of which are believed to be new.

The method of Lagrangian multipliers is presented in a form which does not require the explicit solution for the multipliers themselves. To optimize a set of $n$-variables which are interrelated by $m$-equations of constraint, it is only necessary instead to solve simultaneously a set of $n - m$ determinants of $(m + 1)$th order each set equal to zero, together with the $m$-equations of constraint, in order to obtain directly the optimal values of the $n$-variables.

Applied to problems of process and plant design, it is believed that this method can afford more insight in the synthesis of the mathematical statement of the problem and can be simpler in the execution of the solution than more widely used methods. In particular, it lends itself more readily to numerical evaluation of results where the equations of constraint are transcendental in form.

In the paper, the method is applied to the problem of simultaneously optimizing the cycle pressure ratio, and the regenerator effectiveness, pressure drops, and proportions for maximum thermal efficiency

in a gas-turbine cycle of specified turbine and compressor-inlet temperatures. It becomes clear that the optimization of the regenerator proportions is independent of the optimization of the regenerator effectiveness and that both are independent of the optimization of the cycle-pressure ratio.

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**Heat Transfer Rates to Cross Flowing Mercury in a Staggered Tube Bank,** by R. J. Hoe, Knolls Atomic Power Laboratory, Schenectady, N. Y., D. Dropkin, Cornell University, Ithaca, N. Y., and O. E. Dwyer, Brookhaven National Laboratory, Upton, N. Y. 1956 ASME Semi-Annual Meeting paper No. **56—SA-28** (multilithographed; to be published in Trans. ASME; available to April 1, 1957).

THIS paper covers one phase of an experimental heat-transfer program which has been under way for some time at the Brookhaven National Laboratory. The general purpose of the program is to obtain and correlate heat-transfer coefficients for liquid metals flowing outside of tube banks. The phase studied in this paper is the measurement of heat-transfer coefficients for mercury flowing normal to a staggered tube bank. The factors studied were (a) linear velocity, (b) tube location in the bank, (c) circumferential variation of the local coefficient for a single tube, (d) type of contact, i.e., "wetting" versus "nonwetting," and (e) pressure drop.

The first series of tests consisted of measuring the pressure drop across the lattice as a function of flow rate. During these tests no heat-transfer measurements were made. The flow was regulated by either throttling or by-passing the flow to the test section. Pressure-drop data were taken over the 15,000–80,000 Reynolds-number range, the lower limit being determined by the precision of measurement and the upper one by the capacity of the pump.

The heat-transfer coefficients were determined by supplying a measured heat input to a test element; and, when steady-state conditions were reached, measuring the temperature difference between the tube surface and the bulk stream at several points around the circumference of the tube.

The bulk temperature of the mercury was obtained by taking the average of the temperatures upstream and downstream of the lattice. This temperature difference was very small—usually in the order of 0.5 F.

Since the bulk temperature of the mercury was near ambient, the heat losses from the system were small, thus allowing equilibrium to be reached quite rapidly. The fluid properties used for evaluating the Reynolds number were taken at the average film temperature, which was in general form between 105–115 F.

Data were obtained using the chrome-plated element for 11 different tube locations in the lattice, several runs being made at each location. Two runs were made using a bare copper element at a central tube location and one run at the No. 1 tube location which was at the front of the bank. Since mercury amalgamates readily with copper, these tests were destructive. A copper tube lasted about two days.

The results of the present investigation lead to the following conclusions regarding the cross flow of mercury in a staggered tube bank: (1) The local heat-transfer coefficient varies smoothly from a maximum at the forward stagnation point to a minimum at the rear stagnation point in the Reynolds-number range 15,000–80,000, the magnitude of the variation corresponding to a factor of 4–5; (2) the average heat-transfer coefficient for a tube in the interior of the bank varies as the 0.52 power of the velocity for nonwetted tubes and 0.66 for wetted tubes; (3) for tubes located in the interior of the bank, wetted tubes give heat-transfer coefficients considerably greater than those for unwetted tubes, e.g., at a Reynolds number of $5 \times 10^4$ they are 35 per cent greater. For a tube located in the front row, the difference was found to be much greater, the corresponding figure being 65 per cent; (4) the lower coefficients obtained in the front row of the tube bank compared to those in the interior, for the nonwetted tubes, is in general agreement with results obtained with ordinary fluids; and (5) tubes located at the side walls give coefficients about 20 per cent below those for tubes located in the interior of the tube bank.

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**Apparatus for Measuring the Thermal Conductivity of Liquids at Elevated Temperatures: Thermal Conductivity of Fused NaOH to 600 C,** by C. F. Lucks and H. W. Deem, Battelle Memorial Institute, Columbus, Ohio. 1956 ASME Semi-Annual Meeting paper No. **56—SA-31** (multilithographed; available to April 1, 1957).

THERMAL conductivities of liquids at elevated temperatures are measured using the steady-heat-flow method. Heat introduced into the specimen flows downward through a series-connected, Armco-iron heat-flow meter into a water-cooled sink. The quantity of heat flowing at steady-heat-flow condition is measured from temperature gradients in the heat-flow meter. Guard cylinders, auxiliary heat controls, and insulation minimize lateral heat flow. A hydrogen atmosphere protects the specimen.

The method used for determining thermal conductivities gives true values for the liquid itself, eliminating the effect of liquid-solid interfaces and other fixed thermal resistances. Two or more heat-flow equilibria conditions are obtained at different specimen thicknesses, but at the same mean specimen temperature. Specimen thickness for each equilibrium is plotted against the product of the temperature drop across the specimen and its area, divided by the heat flow.

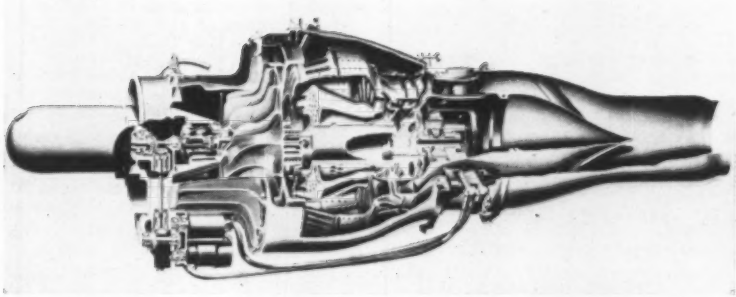
The thermal conductivity is the reciprocal of the slope of a line drawn through these points. The method is equally applicable to liquids having high and low thermal conductivities. The measured values of the thermal conductivity of fused sodium hydroxide are found to vary linearly with temperature, and at 400 and 600 C are 0.0022 and 0.0026 cal per sec per sq cm per deg C cm, respectively.

## Gas Turbine Power

**The J69 Engine—Two Applications of a Small Turbojet,** by Donald J. Todd, Continental Aviation & Engineering Corporation, Detroit, Mich. 1956 ASME Semi-Annual Meeting paper No. **56—SA-62** (multilithographed; available to April 1, 1957).

THIS paper discusses the comparison of requirements of small turbojet engines for target drone and trainer aircraft. The development of small turbojet engines (thrust range from approximately 1000 to 2500 lb) for trainer, target drone, and missile applications has received considerable emphasis in the past few years. The small turbojet engines presently installed in operational aircraft are in the low-thrust range. This paper discusses the engine requirements, performance-development procedures, and the features of the J69 turbojet engines that are installed in a number of the presently operational aircraft utilizing small turbojet engines. The installations of the J69 turbojet engines in the T-37 twin-engine jet trainer and the O-2A target drone are reviewed. The author feels this presents an insight into the major requirements of small turbojet engines for man-carrying and pilotless aircraft.

The T-37 jet trainer is powered by two J69-T-9 turbojet engines, each rated at 920-lb thrust. The T-37, as a trainer aircraft, has been designed to operate efficiently over a wide range of flight plans and operational conditions established by the military services for primary-phase flight training.



**Artist's drawing of cross section of the J69-T-9 920-lb-thrust turbojet engine**

The Q-2A target drone presented in this paper, is powered by a single J69-T-19A turbojet engine rated at 1000-lb thrust. It has been designed for a specific mission and is normally launched from a mother aircraft at altitudes of 15,000 to 20,000 ft.

In comparing the requirements of the J69-T-9 and the J69-T-19A turbojet engines for the T-37 jet trainer and the Q-2A target drone, respectively, the discussion is divided into the following categories: (1) Engine life and reliability, (2) engine operating range, (3) starting and fuel-control systems, (4) requirements for the aircraft systems.

The author discusses the performance-evaluation procedures and the H69 turbojet-engine features at length. Finally the performance achievements are presented for both engines.

The average performance of the J69-T-9 turbojet engines at maximum engine speed of 22,700 rpm shows a net thrust of 935 lb at an exhaust gas temperature of 1210 F and a specific fuel consumption of 1.12 lb of fuel per hour per pound of thrust. A margin of approximately three per cent exists for the average engine over the specification requirement.

The average performance of the J69-T-19A turbojet engines at maximum engine speed of 21,250 rpm shows a net thrust of 1050 lb at an exhaust gas temperature of 1280 F and a specific fuel consumption of 1.175 lb of fuel per hour per pound of thrust. This shows a margin of approximately ten per cent for the average engine over the specification requirement.

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**Some Aspects of Rotating Stall in Single-Stage Compressors,** by M. C. Huppert and Miss Eleanor L. Costilow, NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1956 ASME Semi-Annual Meeting paper No. **56—SA-57** (multilithographed; available to April 1, 1957).

Single-blade-row rotating-stall theories are reviewed in this paper and the absolute stall-propagation rates compared with single-blade-row data. The rotating-stall characteristics of a variety of high hub tip-radius ratio single-stage multiblade-row configurations are presented. The data indicate that the absolute stall-propagation rate is independent of guide-vane turning and is reduced appreciably by a stator-row addition to a particular guide vane-rotor combination. Tests indicate the initiation of rotating stall in a multiblade-row system is dependent upon the over-all system characteristics of the blade-row configuration as well as the individual blade-row characteristics. A flow-stability criterion obtained from one of the theoretical analyses of rotating stall indicate that rotating stall will occur when the static pressure rise of a stage reaches a maximum. This criterion is in substantial agreement with single-stage data presented.

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**Applications of an Enthalpy-Fuel/Air-Ratio Diagram to "First Law" Combustion Problems,** by H. N. Powell, The General Electric Company, Cincinnati, Ohio. 1956 ASME Semi-Annual Meeting paper No. **56—SA-68** (multilithographed; available to April 1, 1957).

This paper develops and illustrates a particularly convenient and general method of dealing with several common combustion problems which involve only applications of the first law of thermodynamics. Particular consideration is given to treating the fuel/air ratio on a continuous rather than incremental basis since in actual applications it is usually the most important independent variable, the combustion temperature and other variables being dependent quantities.

An "absolute" enthalpy is defined which has the advantage that the enthalpy of different systems are similar and compatible quantities regardless of differences in state or chemical composition. However, the use of absolute enthalpies involves no essentially new discoveries or generalizations; it is primarily a "bookkeeping" device which simplifies the solution of many commonly encountered combustion problems and which rests on classical thermodynamic concepts.

An enthalpy-fuel/air-ratio diagram for equilibrium-state combustion gases is formulated using absolute enthalpies. On this diagram, virtually all processes which involve combustion and combustion-product gases—and which are entirely within the scope of the first law of thermodynamics—can be represented by straight lines. Such a diagram therefore provides a very rapid and flexible method of solving many frequently occurring combustion problems.

Procedures for handling the following typical problems are developed: determination of adiabatic flame temperatures, theoretical heat releases, combustion efficiencies (from experimental temperature measurements), and the adiabatic mixing of two streams.

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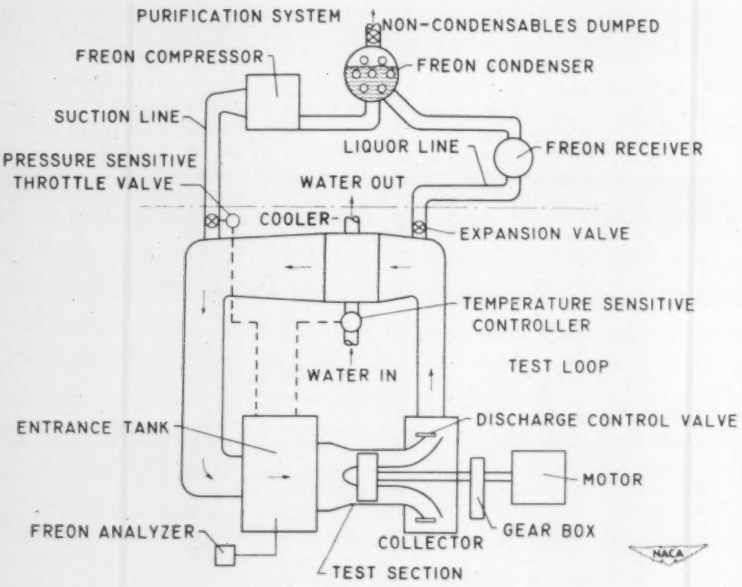
**Problems Encountered in the Translation of Compressor Performance From One Gas to Another,** by M. J. Hartmann and W. W. Wilcox, NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1956 ASME Semi-Annual Meeting paper No. **56—SA-61** (multilithographed; to be published in Trans. ASME; available to April 1, 1957).

In this paper the methods of translating compressor performance from gas to gas are discussed. Some examples are given using air as design gas and Freon-12 as the test medium. Limitations of the system are discussed. The experimental methods and the equipment used in a compressor test rig using Freon-12 as a test medium are given. In addition, the problems encountered are discussed as they may affect the practicability of using Freon-12 or other gases as a test medium.

A flow sheet of Freon testing of a compressor rotor is shown. The test loop is closed. The design is such that a minimum volume of high-pressure test medium is maintained between the compressor rotor and the throttle valve (thus the quantity of Freon in the test loop is kept small). The remainder of the test loop was maintained near atmospheric pressure. The pressure level in the entrance tank was maintained near atmospheric pressure by the quantity of gas in the test loop.

To operate the test loop at 97 per cent (by weight) pure Freon it was necessary to use a purification cycle. Gas mixture was drawn off to the Freon compressor after which it was condensed and the noncondensables (mostly entwined air




**Compressor performance map showing approximate conversion from air to Freon-12**

and vapors) were dumped to the atmosphere. Freon liquid was supplied to the test loop. The purification cycle also was used to control the quantity of fluid in the test loop in the following manner: (1) An expansion-type valve was set to expand the incoming liquid to a gas. (2) An automatic throttling valve, sensitive to the inlet-tank pressure, controlled the quantity of fluid being taken out of the test ring into the purification cycle. The expansion valve could be adjusted to keep the flow quantity within the control range of the valve in the suction line.

From this example some implications are drawn concerning the problems of testing with gases other than air which have been blended to obtain special values of specific heat ratios. A purification system seems necessary to charge the system and maintain the necessary concentration and control as well as to salvage the gas mixtures at the end of a test run. The present concept of a purification cycle is to separate the gases and remix them in their proper proportions. Some gases may be considerably more difficult to separate than the Freon from the leakage air encountered in this test loop. It is necessary to know with considerable accuracy that the gas in the test loop is of the proper mixture. Thus a good method of analyzing these gas mixtures must be worked out. Chemical-absorption or density-balance methods appear too time consuming and tedious. It should not be necessary to operate a compressor test facility for extended periods while the test gas is analyzed and corrected.

Thus there are some problems involved which indicate that testing in such gas mixtures would require considerable development, time, and money. The use of special gas mixtures for testing compressors under certain circumstances is indicated as economical over a very long period, but not as a "quick fix" for extending test facilities.

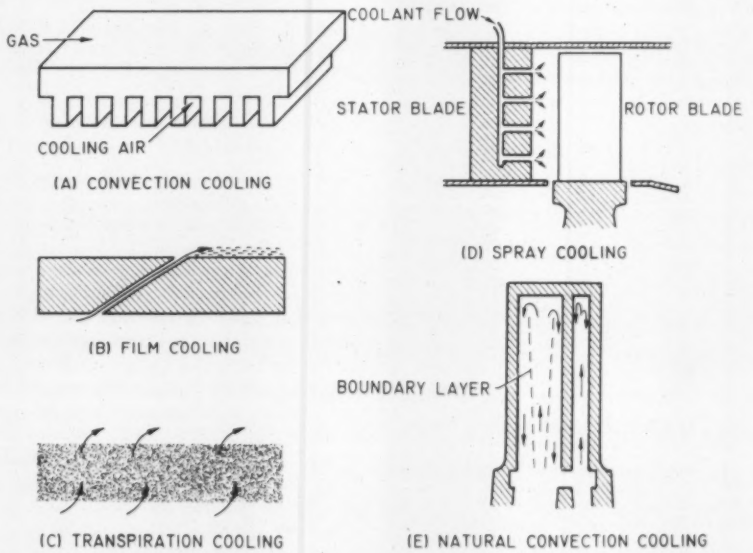
**Research on Application of Cooling to Gas Turbines,** by J. B. Esgar, J. N. B. Livingood, and R. O. Hickel, NACA Lewis Flight Propulsion Laboratory, Cleveland 11, Ohio. 1956 ASME Semi-Annual Meeting paper No. **56—SA-54** (multilithographed); to be published in Trans. ASME; available to April 1, 1957).

THE use of turbine cooling in gas-turbine engines can offer many performance benefits but, at the same time, it may result in added complication to the engine. The advantages that turbine cooling can offer to the engine designer and the results of some of the research that has been expended on the cooling of gas-turbine engines are discussed in this paper. Also an evaluation of several means of turbine cooling is presented to show how the turbine can be made to withstand the conditions of high turbine-inlet temperatures or high stresses for both turbojet and turboprop engines. The most promising methods of air cooling and liquid cooling are discussed.

In conclusion, the authors state that several benefits can be obtained through the use of cooling for some types of operation:

1 The use of cooling to permit higher turbine-inlet temperatures for turboprop and afterburning turbojet engines appears promising because the power is increased without sacrificing specific fuel consumption. For the afterburning turbojet engine, the specific fuel consumption improves as turbine-inlet temperature is increased.

2 For nonafterburning turbojet engines to be used in aircraft at flight conditions where specific engine weight and




**Examples of several types of cooling methods for aircraft gas-turbine blades**

specific fuel consumption are both critical, such as prolonged flight at very high altitudes or very high flight speeds, the use of cooling to permit high-temperature operation appears beneficial. From an over-all-performance point of view, cooling to permit high gas temperatures probably should not be used in nonafterburning turbojet engines at subsonic flight speeds.

3 The thrust specific engine weight can be decreased by increasing the mass-flow capacity of an engine of a given size and weight. This in turn can result in improved aircraft performance. Turbine cooling makes the increase in flow capacity possible by permitting higher turbine stresses and longer turbine blades.

4 Cooling offers the potential of increasing engine life and reliability of all types of gas-turbine engines by cooling the turbine parts enough so that a substantial factor of safety can be built into the turbine design.

5 Much fundamental heat-transfer information that is applicable to cooled turbines has been accumulated so that cooled-engine performance can be calculated.

6 Liquid cooling also appears promising for some turbine applications, but less experience and information are available for liquid-cooled engine design than for air cooling.

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**Facilities and Instrumentation for Compressor and Turbine Research at the NACA Lewis Flight Propulsion Laboratory,** by A. A. Medeiros, and C. C. Conger, NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1956 ASME Semi-Annual Meeting Paper No. **56—SA-65** (multilithographed; available to April 1, 1957).

This paper describes the research facilities and equipment available for compressor and turbine research at the NACA Lewis Flight Propulsion Laboratory. The air supply and exhaust facilities, the component drive equipment, and the flexibility of use of these facilities are described. The various types of compressor and turbine research equipment made possible by these facilities are discussed, and the particular range of application of each type is noted. Some of the instrument requirements of the particular research equipment are pointed out, and a system of automatic data taking and mechanical reduction in use at the NACA is presented.

## Fuels

**Design Criteria for Municipal Incinerators—The Customer's View,** by Abraham Michaels, City of Philadelphia, Philadelphia, Pa. 1956 Semi-Annual Meeting paper No. **56—SA-60** (multilithographed; available to April 1, 1957)

This paper contains a description of municipal refuse, a brief history of refuse-disposal methods, past and present, and a discussion of factors governing the design of an incinerator, including refuse-collection practices, municipal regulations, salvage and utilization of waste heat. A description of various types of incinerator layouts, furnaces, fly-ash removal systems, and residue-removal systems is included, with some figures indicating construction and operating costs. The paper concludes with a statement of what the customer expects of the consulting engineer and what he hopes industry will do to improve incineration methods.

The author declares that there are very few consulting engineers who have sufficient incinerator-design experience to turn in a good job in the area of municipal incineration. He urges mechanical engineers to explore this field thoroughly, so that they might be in a better position to aid municipalities in the solution of disposal problems.

The paper points out that the demand for incinerators is expanding rapidly, and that basically design problems in incinerator construction are similar to those in power-plant design, a field that receives concentrated mechanical engineering attention.

Under factors governing incinerator design criteria, first one must know the quantity of material to be disposed of. The American Public Works Association, through its Committee of Refuse Disposal, is currently starting a nationwide survey to determine an average, which will consider variables such as season, location, and community standard of living.

Next the refuse-collection practice of the municipality must be known, since this will determine the types of material, specific weights, moisture content, and preparation of organic, combustible, and noncombustible materials to be handled. Another consideration is the plant site and its location both with respect to the center of collection and to residential areas which may affect the design of the plant with respect to collection practices and control of air pollution. Still another fact to be considered is the degree of mechanization and automatic control desired by the municipality.

The author described several current installations.

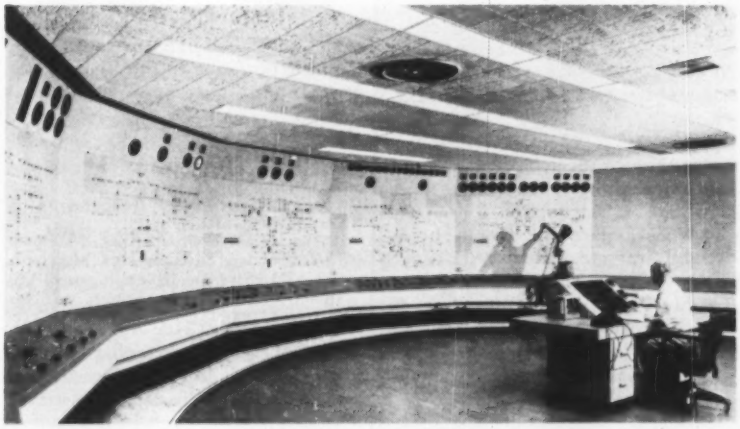
## Rubber and Plastics

**Properties and Applications of Silicone Rubber,** by S. A. Bradley, Jr., Silastic Development, Dow Corning Corporation, Midland, Mich. 1956 ASME Semi-Annual Meeting paper No. **56—SA-53** (multilithographed; available to April 1, 1957).

The properties of silicone rubber are discussed in this paper, and compared to those of organic rubber, particularly at high and low temperatures.

Since silicone rubber was first introduced some 12 years ago, it has advanced from a very weak material with limited applications to what is now a widely used engineering tool. Silicone rubbers are commercially produced that operate at 600 F, 300 degrees above most organic rubbers. There are others that are not frozen at temperatures as low as —170 F.

The properties of silicone rubber are functions of the basic silicone polymer used in its manufacture. Its basic chain is made of many repetitions of silicon and oxygen. The inertness of sand, the commonest form of this chemical group-



**The central control room of the NACA Lewis Flight Propulsion Laboratory**

ing, is well known, and it is this same inertness that gives silicone rubber its unique properties.

The rubber's physiological inertness, dielectric properties, and resistance to various chemicals and oils have led to practical applications which were at one time considered impossible.

A typical application is in tires for jet-plane landing gear, an upper-temperature use not suitable for present organic rubbers.

Baby bottle nipples made of silicone rubber have found favor in hospitals and homes because of their resistance to sterilizing temperatures. Silicone-rubber nipples have been reported to have lasted 15 times as long as ordinary nipples in routine hospital use.

Silicone rubber as insulation for the stator windings of large motors and generators is a new concept in the electrical industry. It has proven valuable for its dielectric properties and also because of its increased thermal stability and moisture resistance. The rubber not only makes an excellent high-temperature insulation, but because silicone rubber when burned leaves only $SiO_2$, a nonconducting ash, wire coated with it does not short out when the insulation is burned.

The ability to remain flexible at very low temperatures has enabled silicone rubber to be used in many places where rubbery seals are needed on today's high-flying aircraft.

Silicone rubber is unaffected by weathering or ozone action. It can be subjected to intensely high ozone concentrations for long periods and show no demonstrable change in properties. Its resistance to chemicals and oil varies with the particular material being tested. It has a good resistance to weak or cool solutions of concentrated acids and alkalis. In aromatic solvents and in chlorinated solvents, silicone rubber swells badly, although upon evaporation of the solvent it returns to its original condition undamaged. It is little affected by the high-aniline-point oils. Therefore, it has been used very widely in the diesel-electric field as O-rings operating against hot lubricating oils.

A pure silicone rubber, after vulcanization and cure, is very inert physiologically. This has led to medical investigations as to its suitability inside the human body. Recently, artificial heart valves have been made from silicone rubber, and research is being done on artificial blood vessels, bile ducts and other subdermal prosthetic devices.

Very few materials will stick to the silicone rubber. Use of this property has been made in such items as rollers for heat-sealing plastic films, and conveyer belts for sticky materials such as glues and foods.

New developments now in the development and research laboratories promise even more widespread application in the future.

## Safety

**Factors in Exhaust Ventilation System Design for the Safety Engineer,** by K. M. Morse, U. S. Steel Corp., Pittsburgh, Pa. 1956 ASME Semi-Annual Meeting paper No. 56—SA-64 (multilithographed; available to April 1, 1957).

CONTAMINANT-CONTROL ventilation as represented by local exhaust ventilation is discussed in this paper. The basic purpose of contaminant ventilation is the maintenance of health and comfort. This is a responsibility of the industrial-hygiene profession and actually has been largely a development of this profession. Since the industrial-hygiene engineer and the safety engineer have common objectives—the health and welfare of industrial workers—it is felt the two professions should work in close cooperation. To this end, the safety engineer should have a basic understanding of contaminant-control ventilation. The general subject of exhaust-ventilation systems is discussed by the author from this viewpoint.

Certain basic principles are involved in ventilation design as in any phase of engineering design:

1 *Pressures.* The motion of air develops a pressure termed "velocity pressure." Air confined within a duct, whether or not in motion, also creates a pressure termed "static pressure." "Total pressure" is the algebraic sum of the velocity and static pressures which is expressed in inches water gage. The practical significance of these pressures is that their values must be determined to evaluate the characteristics and performance of a ventilation system, or in selecting a dust collector, fan, or motor.

2 *Air Flow.* The velocity of air passing through the hood face is termed "face velocity" while that required at the point of contaminant generation, at a specific distance in front of the hood, is termed "capture or control velocity." Exhaust-volume requirements as well as resistance charts are based upon air at 68 F and a barometric pressure of 29.92 in. mercury. When temperatures exceed 100 F or elevations exceed 1500 ft, corrections are necessary.

3 *Flanging.* The use of flanges can reduce air requirements by as much as 25 per cent by drawing air only from in front of the hood.

4 *Power.* It is necessary to maintain a pressure differential between the inlet and outlet of a ventilation system in order to create and maintain a flow of air through the system. This is generally done in a local exhaust system by the use of a fan and motor.

5 *Hood.* The function of the hood is to create a flow of air past the source of contamination and into the hood, sufficient to remove the major quantity of the contaminant. The shape of the hood, its size, location, and air volume are the important design factors.

6 *Duct Design.* Duct design is based upon sizing the duct for the required conveying velocity after establishing the required air flow through each hood, and the development of minimum pressure losses due to friction, elbows, transitions and branch entrances in the main.

7 *Air Cleaner.* Air cleaners remove contaminants from the air. They may be classed into two types; namely, air filters and dust collectors. The need for this provision is based upon good engineering standards and the complications which may arise from discharging heavily contaminated air into the outside air.

8 *Make-Up Air.* Air must be replaced in any building from which air is exhausted, regardless of the method by which the air is removed.

9 *Fan.* The fan and motor combination is the final element in a ventilation system for contaminant control. Fans may be grouped into two general categories; namely, centrifugal and axial flow. The selection of the fan is based upon handling the required air volume at the fan static pressure with minimum horsepower.

The effectiveness of exhaust-ventilation systems can best be insured by the development of an adequate maintenance and testing schedule. Such systems are often costly to install and replace and the mere operation of the fan does not insure adequate system performance.

## Machine Design

**Viscous Damper Design Refinements for Servo-Mechanisms,** by E. J. Hayes, Mechanics in Control Group, Applied Mechanics Laboratory, Silver Springs, Maryland. 1956 ASME Semi-Annual Meeting paper No. 56—SA-40 (multilithographed; available to April 1, 1957).

SOME of the parameters that limit the linearity of the liquid viscous dampers are investigated in this paper, and criteria for the design of dampers are determined; such as sealing, adjustment of damping,

maximum viscosities, and minimum clearance.

Formulas describing damping coefficient as a function of geometry and viscosity are derived analytically for a cylindrical-type damper and empirically for a disk-type damper.

A machine has been built for the purpose of testing rotary viscous dampers at distinct steps of angular velocities, and for the purpose of obtaining the damping sinusoidally by the logarithmic decrement method. A gravity method has also been built and used for a large number of tests, and its description is contained in the paper. Finally, three different types of dampers have been designed, built, and tested; namely, disk, multiple-disk, and cylindrical. These are discussed.

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**The New American Standard for Surface Roughness, Waviness, and Lay, ASA B46.1-1955,** by D. V. Kelly, AC Spark Plug Div., General Motors Corp., Milwaukee, Wisconsin. 1956 ASME Semi-Annual Meeting paper No. **56—SA-48** (multilithographed; available to April 1, 1957).

This paper discusses the new Standard for Surface Roughness, Waviness, and Lay, ASA B46.1-1955, which has been approved by the American Standards Association. The instrument specifications are discussed in detail since they have appeared in a standard for the first time. Classification and designation of surface characteristics are covered briefly.

The inclusion of instrument specifications in the new American Standard for Surface Roughness, Waviness, and Lay is an attempt to provide a uniformity of performance among instruments regardless of manufacture.

The only instrument in widespread use today is the tracer type. Illustrations of the velocity-type tracer are provided, and also of a tracer instrument in which the vertical motion of the stylus is transferred through a liquid-filled viscous-shear coupling to the projecting pin of a movable-anode vacuum tube.

The entire instrument is broken down into two basic areas, and limiting values are assigned to each area: (1) that part of the instrument which determines what surface information is included in the instrument reading and what information is excluded, and (2) that part of the instrument which handles the admitted information and displays the resultant measurement.

The standard further includes the classification and designation of surface characteristics, instrument specifications, and specifications for both precision reference and comparison specimens.

# ASME Transactions

**for October, 1956**

The October, 1956, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

## Technical Papers

An Investigation of Cemented Tungsten Carbide as Bearing Material; Progress Report No. 2, by J. S. Kozacka, H. A. Erickson, H. W. Highriter, and A. F. Gabriel. (54—F-3)

Thermal Lags in Flowing Incompressible Fluid Systems Containing Heat Capacitors, by J. W. Rizika. (54—SA-50)

A Systematic and Rapid Procedure of Computing Approximate Characteristic Values Pertaining to Bare-Tube Crossflow Heat Exchangers, by F. J. Neugebauer. (54—SA-40)

Validity of Time-Compensated Temperature Parameters for Correlating Creep and Creep-Rupture Data, by F. Garofalo, G. V. Smith, and B. W. Royle. (55—A-164)

Mechanical Properties at Elevated Temperatures of Ductile Cast Iron, by F. B. Foley. (55—A-204)

Structural Stability of Modified 12-Chromium Alloys, by W. C. Hagel and E. F. Becht. (55—A-173)

Review of the Pitot Tube, by R. G. Folsom

Pulsation Errors in Manometer Gages, by T. J. Williams. (55—A-92)

A Practical Pulsation Threshold for Flowmeters, by V. P. Head. (55—A-188)

Effect of Range of Stress in Combined Bending and Torsion Fatigue Tests of 25S-T6 Aluminum Alloy, by W. N. Findley, W. I. Mitchell, and D. D. Strohbeck. (55—A-68)

The Influence of Shank Area on the Tensile Impact Strength of Bolts, by John Love, Jr., and O. A. Pringle. (55—A-77)

New Techniques in Metal-Cutting Research, by W. R. Backer and E. J. Krabacher

Heat Transfer to, and Temperature Distribution in, a Metal-Cutting Tool, by D. L. Rall and W. H. Giedt. (55—A-217)

An Analysis of the Orthogonal Boring Operation, by B. W. Schaffer. (55—A-67)

Report of the Investigation of the Turbine Wheel Fracture at Tanners Creek, by A. W. Rankin and B. R. Seguin. (55—A-210)

Investigation of Large Steam-Turbine Spindle Failure, by H. D. Emmert. (55—A-172)

Report of the Investigation of Two Generator Rotor Fractures, by C. Schabtach, E. L. Fogleman, A. W. Rankin, and D. H. Winne. (55—A-208)

Large Rotor Forgings for Turbines and Generators, by N. L. Mochel, R. E. Peterson, J. D. Conrad, and D. W. Gunther. (55—A-215)

Acceptance Guides for Ultrasonic Inspection of Large Rotor Forgings, by A. W. Rankin and C. D. Moriarty. (55—A-194)

Work of the Task Group on Brittle Failure of Steel Forgings, by A. O. Schaefer. (55—A-209)

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# Comments on Papers

## Including Letters From Readers on Miscellaneous Subjects

### Computers and Production Engineering[1]

**Comment by M. E. Salveson[2]**

THE author has given a substantive review[1] of many of the recent production problems which have been solved by the application of large-scale computers.

The new large-scale computer is a powerful tool, but like all tools its role and relationship must be understood before it can make its maximum contribution.

In order to discern the role of the computer, let us examine the role of computing. The chain of processes in which computing takes place is shown in Fig. 1.

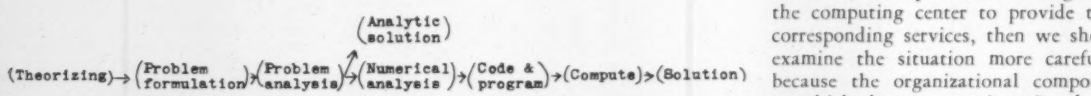



**Fig. 1 Demonstrating the chain of processes which take place in computing**

The essential point to make is that this is a chain, and the familiar aphorism, "A chain is no stronger than its weakest link," holds also in this case. Thus one should ask when considering a computer, are our methods of theorizing, problem formulation, and problem analysis as modern as our computer?

The author refers frequently to "management" problems, which are closely associated with production engineering. In practical business contexts, it often is necessary to take an even broader view—one which looks simultaneously at the whole business. This is necessary for at least two reasons:

1 The business is a unit, not a loose federation, and its efficiency is the function to be maximized not just the efficiency of production, marketing, accounting, or some other element. Hence, in considering the whole class of applicable problems, one should recognize that outputs of some problems are inputs to others. Hence, a unified systems approach for the business is desirable—even to the design of the form of input-output for problems, relative timing of solution of problems, and so on.

2 Often, two or more functional components of the business will make use of a computing system. In these situations, it will be necessary to make certain fundamental decisions:

(*a*) What services will be offered as part of the computing service?

(*b*) Who will own or have jurisdiction over the computer and what will be the nature of that jurisdiction?

In a sense, these two questions are related. However, initially, we will treat them somewhat separately. With respect to the chain of processes (Fig. 1), the first two clearly are oriented toward the functions with which they are associated and, hence, should not be affiliated with the computer group as services offered by it. Problem or mathematical analysis is oriented less toward the function from which the problem originates, and less toward the computing function, but more toward the relevant field of analysis, such as mathematics and/or statistics. Since, at this stage, the decision is made to solve the problems analytically or numerically with the computer, objectivity in deciding to use the computer requires that this service not be offered as part of the computing service. The fourth, numerical analysis, is more oriented toward the suitability of various numerical methods and the abilities of computers, particularly those available in the business. Since familiarity with the computer is desired, there is a good case for locating this service in the computing center, especially if the work load from any one function is not heavy enough to sustain a competent, numerical analyst full time.

Coding and programming are services which efficiently can be offered by a computing center. However, even in this instance, it is often efficient to have business-procedures analysts do their own coding and programming. Of course, the computing equipment and operating personnel should be in the computing center.

The answer to the second question is affected by which of these processes are assigned to the computing center. If only the computer and its operating personnel are included in the computing center, then it is necessary to assure that the functional component to which it is assigned will schedule its use so as to give all needing to use the computer reasonable access to it. If for some reason more of the processes are assigned to the computing center to provide their corresponding services, then we should examine the situation more carefully, because the organizational component to which the computer is assigned then could have a larger effect upon the concepts, purposes, and policies for using the computer. In this case, we should seek answers to certain questions to guide our decision, such as:

1 What are the objectives of the computing center in relation to the whole of the business?

2 What skills, training, and knowledge are necessary to supervise and carry out the work of the center?

3 What is the way of combining these skills and work processes into homogeneous, compatible positions?

4 What is the way of relating these positions to others in the business so as to give manageable packages and maximum attainment of the objectives of the whole?

Tabulating equipment, which some view as the antecedent of large computers, traditionally has been assigned to accounting, although many businesses have found, through seeking answers to these questions, that additional installations were needed in manufacturing and engineering. Because of the cost of large computers, unnecessary duplication of equipment no longer may be economical. Hence, a logical answer must be found. These questions then give rise to basic

[1] "Electronic Computers Solving Production-Engineering Problems," by C. R. De Carlo, MECHANICAL ENGINEERING, vol. 78, May, 1956, pp. 416–418.

[2] General Electric Company, New York, N. Y. Mem. ASME.

questions, such as, "Is this work more like science than accounting?" "Who could supervise and guide it best, an accountant or a scientist?" "Does accounting have more to offer science, or science more to offer accounting?" "Is the computing service for the whole or for a component?"

In conclusion then, we have returned to our original point—that in looking at computers, we must recognize them as part of a whole, and that it is the objectives of the whole which should be uppermost in our minds in making these decisions on when, where, and how to use a computer.

### Comment by P. D. Wickersham[3]

THE author has presented an interesting and comprehensive survey of the application of computers to production-management problems. Although the application of large-scale computers to problems within this category has lagged behind their application to such problems as billing, accounting, and the solution of complex engineering-research problems it may well be that this use of computer facilities will find equal or possibly greater rewards in the saving of cost and manpower.

Many of the problems which the author gives as examples have been discussed frequently within the realm of "operations research." It is interesting to note the comment regarding the application of stochastic methods to productivity measurements in the use of linear programming. The use of statistics in both engineering and management, although not new in any sense, is becoming more and more widespread in its application. The large amount of data necessary for establishing these methods makes the use of computers having large volume capacity almost essential.

A certain amount of discussion in the paper is devoted to the applicability of dynamic analysis to problems which heretofore have been considered basically static. The introduction of the concepts of servomechanisms theory into the typical management problem is certainly an attempt to apply a powerful tool to the solution of what is essentially a dynamics problem. We wonder whether in the handling of problems such as these, and those similar to the example given by the author of the design of a fractionating and refining system, the application of the differential-analyzer type of analog computer would not find a direct and suitable application. The process of optimizing parameters in a dynamic system is often best handled by analog computers.

[3] Head, Instrumentation Section, American-Standard Atomic Energy Division, Redwood City, Calif.

## The Professional Engineer

### Comment by Waldemar S. Nelson[4]

THE author has broached a difficult subject[5] and one affecting directly the well-being of professional engineers, their clients, and the profession itself. He is to be commended for making a direct and honest approach to the problem.

It can be argued that whereas the cost of living has increased tremendously over the past 25 years, so has the cost of construction. A building erected for $100,000 in 1930 would cost $225,000 to build today. If engineer's fees are determined as a percentage of the construction cost, then the engineer's gross income should have increased accordingly.

But gross income does not give the entire picture. The cost of performing engineering work has increased in other ways beyond the direct increase in employees' salaries. Social Security and Unemployment Insurance taxes, Compensation Insurance, paid holidays, paid vacations, group insurance and hospitalization fees all create costs so that the total additional payroll burden from these sources may be 20 per cent or more of the net payroll.

We do not begrudge these additional costs; on the contrary the engineer and his profession are benefited when he can work on a respectable salary basis as a respected professional rather than as a piece-rate designer in the "engineering sweat shops" of the 'twenties, but the development of a more professional approach and a better economic position for the engineer has increased the cost as well as the quality of engineering work.

***Additional Services Required.*** An additional increase in the cost of engineering arises because the engineer is called on to furnish additional services to the client not formerly required. Today's complex industrial projects and buildings, as well as civil and military works require more detailed drawings, more exact specifications than those of yesterday; and it is a rare job that does not require the engineer to supervise some special analysis, soil investigation, metallurgical examination, radiographic inspection or weldment testing. Such service consumes the engineer's time, energy, and money and increases the cost of engineering.

The practice of competitive bidding for professional engineering work is repugnant to the concept of a profession. The award of engineering work on the basis of the lowest price bid is not to the best interest of the client, the owner, or the public. We believe these practices arise from ignorance on the part of the client as to what he is procuring when he engages an engineer, and failure on the part of engineers to explain properly their services to the public at large and to the clients in particular.

***Correcting the Situation.*** Solution of the problem probably lies in a twofold approach; (1) educating the public and the clients as to the engineer's function and, (2) policing the practice of engineering from within the profession. The author's suggestion of a uniform and simplified schedule of fees is an excellent start on both of these approaches. A fee schedule to be enforceable must be workable and, as he points out, most of the published fee schedules today are too vague and too flexible to be usable by the profession in eliminating irresponsible practice. They are also too complicated to permit general dissemination to the public and to those clients who frequently engage engineers. A flat minimum fee would be readily understandable by all parties involved and could be used as a standard by the profession. The proposed flat fee would have to be modified to adjust for the sharp break at the $150,000.00 bracket, but the basic principle merits serious consideration by the professional societies involved.

[4] Consulting Engineer, New Orleans, La. Mem. ASME.

[5] "What Price the Professional Engineer?" by James M. Todd, MECHANICAL ENGINEERING, June, 1956, vol. 78, pp. 515-516.

### Author's Closure

Mr. Nelson rightfully emphasizes the fact that even though the professional engineer's fee—when normally based on a percentage of the cost of the work—increases with the increased costs of construction, this still does not properly cover all the added costs of engineering services. In addition to the added costs of fringe benefits, income taxes, and other details listed by Mr. Nelson, the engineering assistants, draftsmen, and other aides of the professional engineer, while professional-minded, are normal human beings—and on today's level just do not develop the amount of work, in the same time period, that the "engineering sweatshops" of the 'twenties did accomplish. The 20 per cent payroll increase mentioned by Mr. Nelson does not recognize today's production abilities.

Such ignorance on the part of clients,

as pointed out by Mr. Nelson, in contracting for engineering services is basically the fault of the engineering profession. We have not been successful, in such meager efforts as we have put forth in the past, in educating the engineer-employing factors of our American economy, on the services to be given, and expected from, the professional engineer. The functions of the professional engineer have been very clouded by past practices; and the engineering profession itself is not blameless in this poor understanding of professional services. The engineering societies, both local and national, have been very hesitant to inject themselves into the matter of public education on fees and salaries of the practicing engineer. Even the economic-uplift effort of the National Society of Professional Engineers has not been too successful. Only the "so-called" shortage of engineers in the present day seems to have been serious enough to make both industry and private engineering employers wake up to the facts of a terribly underpaid profession.

Policing of the practice of engineering will not be easy—if at the same time we properly wish not to be classified as a union or closed corporate group. It is difficult, even in cases of apparent flagrant violations, to pin down the necessary facts for conviction. Most professional men are loathe to accuse a fellow engineer—in fact, our professional ethics would seem to prevent us from making any public outcry against a fellow professional. We just cannot legislate morals into the profession of engineering. Possibly our only answer is the development of a better professional conscience during the student and apprentice days of our professional brothers.

James M. Todd.[6]

[6] James M. Todd & Associates, New Orleans, La. Past-president and Fellow ASME.

# Reviews of Books

## And Notes on Books Received in Engineering Societies Library

### Environmental Control Ventilation

PLANT AND PROCESS VENTILATION. By W. C. L. Hemeon. The Industrial Press, New York, N. Y., 1955. Cloth, $5^3/_4 \times 9$ in., tables, figs., problems, index, ix and 437 pp., $9.

ENGINEERING MANUAL FOR CONTROL OF IN-PLANT ENVIRONMENT IN FOUNDRIES. American Foundrymen's Society, Des Plaines, Ill., 1956. Cloth, $8 \times 11^1/_2$ in., bibliography, glossary, indexes, appendixes, figs., tables, v and 145 pp., $7.75.

**Reviewed by F. S. Mallette**[1]

THE troublesome problems of estimating required air volumes and plotting the desirable flows are rightly emphasized by W. C. L. Hemeon who believes that engineers are usually too engrossed with the satisfactions of symmetrical duct design and proper fan selection when planning an industrial ventilation system.

The intensive practice of industrial hygiene engineering in the past 30 years has provided comprehensive experience which permits the translation of design principles to handbook-data form. Thus, he points out, environmental control can progress from an art to a somewhat less than exact science in which the inexperienced engineer may find guidance in tabulated information. In his book, he has made a considerable contribution to this goal.

A most useful section is devoted to the proper analysis of factory-ventilation problems—the foundation upon which any efficient system must be based. Yet this is where many designs fail because of misplaced assumptions.

While basing the principles set forth on theoretical considerations, the author suggests sufficient general applications to permit adaptation to specific problems. In the Foundrymen's Manual, as might be expected, specific problems of modern foundry practice and their control are the end result. Developed by a distinguished Dust Control and Ventilation Committee of which Herbert J. Weber is secretary, the purposes of the Manual are "to provide help for smaller foundries lacking engineering staffs, to standardize good practices in all foundries, regardless of size (and) to provide guides to making the foundry an even safer and better place to work."

The Manual contains the fundamental principles of earlier publications which began when the Safety and Hygiene Section of American Foundrymen's Society was instituted in 1935. The codes of recommended good practices developed by the original Industrial Hygiene Codes Committee are still valuable and are wisely retained, in essence, in the present Manual.

Both books, which are usefully indexed, will be of assistance to industrial engineers who are faced with problems for which specialists are not available.

[1] Executive Secretary, ASME Committee on Air-Pollution Controls, New York, N. Y. Mem. ASME.

## Books Received in Library

ABACS OR NOMOGRAMS. By A. Giet. 1956, Philosophical Library, Inc., New York, N. Y. 225 p., $5^1/_2 \times 8^3/_4$ in., bound. $12. This book demonstrates, for practicing engineers, how nomograms may be constructed without highly specialized mathematical knowledge. The subject matter is presented in five parts covering the relations between two variables; Cartesian abacs; alignment charts based on parallel co-ordinates; alignment charts not based on parallel co-ordinates; and relations between $n$ variables. The French units of the original have, in some cases, been converted to British units, and conversion factors are included for numerical examples.

ASTM STANDARDS ON ELECTRICAL INSULATING MATERIALS (1956). Published annually by the American Society for Testing Materials, Philadelphia, Pa. 642 p., $6 \times 8^7/_8$ in., paper. $6. A compilation of 83 standards covering insulating shellac and varnish, ceramics products, fabrics and papers, mica products, filling and treating compounds, mineral oils, plastics, etc. A number of electrical tests

and conditioning requirements for testing are also included.

ATMOSPHERIC POLLUTION, ITS ORIGINS AND PREVENTIONS. By A. R. Meetham. 1956, Pergamon Press, Inc., New York, N. Y. 302 p., $5^3/_8 \times 8^1/_2$ in., bound. $11. This is a general approach to the subject, intended to provide engineers, public-health officials, and other interested readers with a foundation for more technical studies. It includes discussion of fuels, fuel-burning appliances, and industrial processes as sources of pollution, as well as information on measurement, distribution, effects, and remedial measures. This edition includes a new chapter covering pollution in fogs, pollution from nuclear reactions, and recent trends in Great Britain. A bibliography has also been added.

BIBLIOGRAPHIC SURVEY OF CORROSION 1952–1953. Publication No. 56-11. Published 1956 by National Association of Corrosion Engineers, Houston, Texas. 382 p., $8^1/_2 \times 11^1/_4$ in., bound. $12.50. Summaries of over 3000 references on corrosion and corrosion prevention are arranged in the following main groups: general, testing, characteristic phenomena, corrosive environments, preventive measures, materials of construction, equipment, and industries. The references are indexed by subjects and by authors. An appendix has been included to aid the user in locating and obtaining copies of foreign or domestic journals or articles.

BIBLIOGRAPHY OF HARDNESS AND HARDNESS TESTING FROM 1937 TO 1955. Published 1955–1956 by the Industrial Diamond Information Bureau, London. 118 p., $7^3/_8 \times 9^3/_4$ in., paper. 5s 6d. This bibliography includes a chronological list of references from scientific and technical journals, a section on textbooks, and a list of the standards of a number of countries. English translations of foreign language titles are given, available abstracts or translations are noted, and a system of symbols is used to indicate the contents of the references. The bibliography is indexed by trade names, authors, general subjects, and materials tested.

CAMS; DESIGN, DYNAMICS, AND ACCURACY. By Harold A. Rothbart. 1956, John Wiley and Sons, Inc., New York, N. Y. 350 p., $5^7/_8 \times 9^1/_4$ in., bound. $9.50. Written for design engineers and students, this is both a theoretical and practical treatment covering methods of construction and characteristic equations of basic curves; mathematical methods for determining cam size and profile; advanced curves for high speeds and special motions; and polydine cams. The book also deals with the dynamics of high-speed cam systems, force analysis, and profile accuracy. The last chapter is a discussion of special cams and their applications to various kinds of machinery.

CATALYSIS. Volume 4. Hydrocarbon Synthesis, Hydrogenation, and Cyclization. Edited by Paul H. Emmett. 1956, Reinhold Publishing Corporation, New York, N. Y. 570 p., $6 \times 9^1/_4$ in., bound. $12.50. Continuing the summary of existing knowledge of the theory and practice of catalysis begun in previous volumes of this series, the present volume deals primarily with the Fischer-Tropsch synthesis and related syntheses of particular interest to the petroleum and coal industries. Eight chapters by various authorities are included, of which four cover Fischer-Tropsch reactions and catalysts and the remaining four cover liquid-phase hydrogenation of coal and tar, cyclization and aromatization of hydrocarbons, isosynthesis, and methanation. Extensive lists of references accompany each chapter.

## Library Services

ENGINEERING SOCIETIES LIBRARY books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

CHEMICAL ENGINEERING KINETICS. By J. M. Smith. 1956, McGraw-Hill Book Company, Inc., New York, N. Y. 402 p., $6 \times 9^1/_4$ in., bound. $8. This is a presentation, for practicing engineers and advanced students, of design methods for reaction equipment and their application to practical problems. Emphasizing process rather than plant design, the book reviews the fundamentals of thermodynamics and kinetics, presents the construction features and design principles for several types of reactors, and discusses in detail the design of homogeneous batch, homogeneous flow, semibatch, and catalytic reactors. The next to last chapter discusses heat and mass transfer in catalytic reactors as preparation for the final chapter which deals with the complex problem in which heat-transfer, mass-transfer, and chemical-reaction processes all affect the design.

DESIGN AND CONSTRUCTION OF STEEL MERCHANT SHIPS. Edited by David Arnott. 1955, The Society of Naval Architects and Marine Engineers, New York, N. Y. 494 p., $8^1/_8 \times 11^1/_8$ in., bound. $14. A detailed and practical presentation of methods for the design and construction of ordinary merchant vessels, intended as a text for students and as an introduction to the subject for engineers and others entering the shipbuilding field. In addition to dealing with design principles, materials, methods of joining, and the design of members, the book includes chapters on outfitting, design of interiors, cargo-handling arrangements, heating and ventilating, piping systems, life-saving equipment, and hull preservation and maintenance. The volume also includes a survey of the historical development of ship construction and a discussion of practices currently used in shipyards.

DIESEL OPERATION AND FAULT DIAGNOSIS. By Gerald B. Fox. 1956, The Macmillan Company, New York, N. Y. 191 p., $5^7/_8 \times 9$ in., bound $4.50. Written for the users of both small and large types of engines, this book describes the various components in simple language and shows how faults can be diagnosed. Injection systems, instruments, air compressors, superchargers, starters, pistons, and bearings are dealt with, and there are chapters on fuels, lubrication, engine tuning, and the keeping of maintenance and overhaul records. The last chapter gives descriptions of twelve current British engines.

DIGITAL DIFFERENTIAL ANALYZERS: AN APPLICATIONS MANUAL FOR DIGITAL AND BUSH-TYPE DIFFERENTIAL ANALYZERS. By George F. Forbes. Third Edition, 1956. Published by George F. Forbes, Pacoima, Calif. 154 p., $8^3/_8 \times 10^3/_4$ in., paper. $7.50. Added to this edition are over a hundred pages of new material covering trajectory problems, simultaneous algebraic equations, partial differential equations, complex functions, conformal mapping, etc. The first part of the manual, a reprint of the second edition, shows the basic integrator mechanisms for the generation of exponential, trigonometric, algebraic, and inverse trigonometric functions, and discusses adders and servos and their uses. Diagrams are used throughout to show the setting up of the various operations; exercises are included.

DYNAMIC FACTORS IN INDUSTRIAL PRODUCTIVITY. By Seymour Melman. 1956, John Wiley and Sons, Inc., New York, N. Y. 238 p., $5^1/_2 \times 8^1/_4$ in., bound. $4.75. This is an investigation, based on British and American experience, of the effects on manufacturing productivity of the relative cost of man-hours and machine-hours, and of the rise of administrative overhead. The study includes a chapter on engineering implications which shows how the changing relation of the costs of men and machines can be taken into account in the design of production facilities.

ELECTRONIC MEASUREMENTS AND MEASURING INSTRUMENTS. By F. G. Spreadbury. 1956, Essential Books, Inc., Fair Lawn, N. J. 459 p., $5^3/_8 \times 8^5/_8$ in., bound. $8. This work is devoted to describing fully certain basic types of instruments: voltmeters, ammeters, wattmeters, stroboscopes, the cathode-ray oscillographs, photoelectric cells, etc. Instruments for frequency and time measurement, electron optical systems, and ac bridges are also covered, and consideration is given to tube characteristics, auxiliary apparatus, power supply, and construction practice.

ENGINEERING AS A CAREER. By Ralph J. Smith. 1956, McGraw-Hill Book Company, Inc., New York, N. Y. 365 p., $5^7/_8 \times 9^1/_4$ in., bound. $4.75. This book introduces the beginning engineering student to the nature of the profession, to the type of studies he will be engaged in during his four years of college, and to selected topics in civil, electrical, and mechanical engineering. The qualifications, duties, and responsibilities of the engineer are indicated, and the profession is described both in terms of the major branches and in terms of functions—research, design, construction, management, etc. Materials, mechanics, thermodynamics, electrodynamics and engineering economy are the engineering subjects introduced.

ENGINEERING MECHANICS. By S. Timoshenko and D. H. Young. Fourth Edition, 1956. McGraw-Hill Book Company, Inc., New York, N. Y. 478 p., $6 \times 9^1/_4$ in., bound. $7.50. The fourth edition of this standard text aims, like preceding editions, to acquaint the student with as many general methods of attack as possible, and to illustrate the application of these methods to practical engineering problems. In preparing the new edition, the authors have endeavored to simplify the presentation and have de-emphasized the algebraic treatment of problems by giving them with numerical data and numerical solutions.

ÉTUDE DE LA LUBRIFICATION SOUS PRESSION RAPIDEMENT VARIABLE. By Fernand Charron. Publications Scientifiques et Techniques No. 310. 1956, Ministère de L'Air, Paris. 27 p., $7 \times 10^5/_8$ in., paper. Francs 450. Certain lubricants, greases, etc., appear to have a shearing coefficient as well as a coefficient of

viscosity. This pamphlet is a study of the behavior of such anisotropic lubricants under rapidly varying pressure conditions.

ÉTUDE EXPÉRIMENTALE DES ÉCOULEMENTS GAZEUX. By Marie Merle. Publications Scientifiques et Techniques No. 308. 1956, Ministère de L'Air, Paris. 87 p., $7^1/_8 \times 10^3/_8$ in., paper. Francs 1100. Part 1 describes various optical and acoustic methods for the investigation of gas flow. In Part 2 these experimental methods are applied to actual investigations of low-speed aerodynamic flow, sonic and supersonic air jets, shock tubes, etc.

EVALUATION OF INSULATING OILS—EUROPEAN DEVELOPMENTS. (Special Technical Publication No. 172). Published 1956 by the American Society for Testing Materials, Philadelphia, Pa. 72 p., $6 \times 8^7/_8$ in., paper. $1.75. Research in Sweden, France, and England on the testing of insulating oils is reported in the following three papers included in this publication: Catalysts for Accelerated Testing of Transformer Oil; The Performance Characteristics of Used Insulating Oil; and The Evaluation of Inhibited Transformer Oils. Discussion of the papers is also included.

THE GENERATION OF ELECTRICITY BY WIND POWER. By E. W. Golding. 1956, Philosophical Library, Inc., New York, N. Y. 318 p., $5^1/_2 \times 8^3/_4$ in., bound. $12. This account of recent research and development work on the use of wind power on a significant scale is divided, roughly, into three parts. Part 1 is devoted to wind behavior and its determination: wind distribution, measurement of velocity, energy estimation, and the selection of sites for wind power units. The remaining two parts deal, respectively, with types of wind-driven machines and generators, and with economic considerations. In addition to chapter bibliographies, a bibliography on surface-wind data, is included. A glossary of French, German, and English terms is appended.

GEOPHYSICAL CASE HISTORIES. Volume 2. Published 1956 by The Society of Exploration Geophysicists, Tulsa, Okla. 576 p., $6^1/_2 \times 9^1/_4$ in., bound $7. This volume is made up of 53 case histories grouped in the following seven sections: general and historical; salt domes; anticlines; reefs; stratigraphic traps; mines; and new uses. Seismic records and maps accompany many of the papers. Some of the papers are reprinted from publications of the Society of Exploration Geophysicists and the American Association of Petroleum Geologists.

HIGH-SPEED COMBUSTION ENGINES. By P. M. Heldt. 16th Edition, 1956. Chilton Company, Philadelphia, Pa. 805 p., $5^1/_2 \times 8^3/_8$ in., bound. $12. A complete revision of a standard work on the theory, design, production, and operation of the high-speed combustion engine. In revising the book, indicator diagrams, torques curves, and bearing-load diagrams have been redrawn to bring them into line with current practice, and drawings of parts have been replaced or supplemented with drawings of parts of recent design. In addition to other textual changes, material on liquefied petroleum gases as fuels has been added and the chapter on tests has been considerably enlarged.

HYDRAULICS REFRESHER FOR PROFESSIONAL ENGINEER'S LICENSE. By John D. Constance. Second Edition, 1956. Published by John D. Constance, Cliffside Park, N. J. Various paging, $8^3/_8 \times 10^7/_8$ in., paper. $3. These selected examination questions, with worked-out solutions, deal with hydrostatics, hydrodynamics, circular orifices, weirs, flow through open channels, pipe flow, and centrifugal pumps. Concise reviews of each subject precede the illustrative problems. New topics included in this edition are specific gravity and density relations; valve-testing conversions; branch-piping networks; and nozzle horsepower.

THE INTERFERENCE SYSTEMS OF CROSSED DIFFRACTION GRATINGS. By J. Guild. 1956, Oxford University Press, New York, N. Y. 152 p., $5^1/_2 \times 8^3/_4$ in., bound. $4. This book is intended to provide a comprehensive theoretical background for engineers and physicists concerned with the practical application of moiré fringes to linear measurement and the automation of machine tools. The main subjects discussed are fundamentals of grating action, methods of observation, the operation of two gratings in series, characteristics of the fringe system, metrological characteristics, and the influence of grating defects. A brief list of references is appended.

LINEAR TRANSIENT ANALYSIS. Volume 2. Two-Terminal-Pair Networks Transmission Lines. By Ernst Weber. 1956, John Wiley and Sons, Inc., New York, N. Y. 452 p., $5^7/_8 \times 9^1/_4$ in., bound. $10.50. In this text for graduate students, the Fourier and Laplace transform methods (reviewed in the first chapter) are applied to the analysis of transient phenomena in passive and active two-terminal-pair networks, in filters, and in transmission lines. The book includes an extensive discussion of the application of the Fourier transform method in the idealization of the network characteristic and a careful development of the traveling-wave concept.

MINIMUM WEIGHT ANALYSIS OF COMPRESSION STRUCTURES. By George Gerard. 1956, New York University Press, New York, N. Y. 194 p., $6 \times 9^1/_4$ in., bound. $6. The first two chapters of this book discuss the minimum-weight analysis of aircraft structural elements and the behavior of composite structures as background for a detailed analysis, in chapters three to seven, of specific structural arrangements. These include post construction; sandwich plate, box, and shell constructions; multicell construction, and other types. The last four chapters deal with the comparison of the various types of construction; practical considerations in favoring one form over another; properties of materials for minimum-weight applications; and ideal stress. There is a bibliography.

# ASME Boiler and Pressure Vessel Code

## Interpretations

THE Boiler and Pressure Vessel Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting, interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting August 16, 1956, and approved by the Board on September 27, 1956.)

### Case No. 1204-3

### (Reopened) (Special Ruling)

*Inquiry:* Is it permissible in welded construction conforming to the requirements of Section VIII of the Code to use quenched and tempered steel plate and forgings conforming to the requirements of the following specifications?

(1) *Scope.* This specification covers alloy-steel plates of firebox quality and alloy-steel forgings intended particularly for use in welded pressure vessels.

(2) *General Conditions for Delivery.* Material furnished under this specification shall conform to the applicable requirements of the current edition of the Tentative Specification for General Requirements for Delivery of Rolled Steel Plates of Flange and Firebox Qualities (ASTM Designation: A20) except as herein modified.

(3) *Process.* The steel shall be made by either or both of the following processes: open-hearth or electric furnace.

(4) *Heat Treatment.* The material shall be treated by the material manufacturer to produce the tensile requirements of Table 2 by heating to not less than 1650 F, quenching in water between 50 and 100 F, and tempering to not less than 1150 F with a holding time of one hour per inch of thickness, but in no case less than one-half hour.

(5) *Chemical Composition.* The steel shall conform to the chemical requirements prescribed in Table 1.

If the material is subjected to check analysis, the AISI standard permissible variations apply.

**Table 1 Chemical Requirements**

| | PER CENT |
|---|---|
| Carbon | 0.10/0.20 |
| Manganese | 0.60/1.00 |
| Phosphorus, max | 0.035 |
| Sulfur, max | 0.040 |
| Silicon | 0.15/0.35 |
| Nickel | 0.70/1.00 |
| Chromium | 0.40/0.80 |
| Molybdenum | 0.40/0.60 |
| Vanadium | 0.03/0.10 |
| Copper | 0.15/0.50 |
| Boron | 0.002/0.006 |

(6) *Tensile Properties.* The material as represented by the tension test specimens shall conform to the requirements as to tensile properties prescribed in Table 2.

**Table 2 Tensile Requirements**

| | |
|---|---|
| Tensile strength, psi, min | 105,000 to 135,000 |
| Yield strength, psi, min | 90,000 |
| Elongation in 2 in. min, per cent | 17 |

(7) *Bending Properties.* The bend test specimen shall stand being bent cold (room temperature) through 180 deg without cracking on the outside of the bent portion to an inside diameter which shall have the relation to the thickness of the specimen prescribed in Table 3. When the test is made on a specimen reduced in thickness, the rolled surface shall be on the outer curve of the bend.

**Table 3 Bend Diameters**

| Thickness of Material | Ratio of Bend Diameter to Thickness of Specimen |
|---|---|
| 1 in. and under | 2 |
| Over 1 to 2 in., incl. | 3 |

(8) *Test Specimens.* The test specimens shall be prepared from the material in its heat-treated condition, or from full-thickness samples similarly and simultaneously treated.

(9) *Number of Tests for Plates.* One tension test longitudinal from the bottom, one tension test longitudinal from the top, and one bend test transverse from the top shall be made from each plate as heat-treated. One homogeneity test shall be made from each plate as rolled.

NOTE: The term "plate as rolled" used here refers to the unit plate rolled from a slab or directly from an ingot in its relation to the location and number of specimens, not to its condition.

(10) *Number of Tests for Forgings and Formed Parts.* One tension and one bend specimen shall be made of each heat of material included in any one heat-treatment lot.

*Reply:* It is the opinion of the Committee that the material specified in the Inquiry may be used in the construction of welded pressure vessels under the rules of Section VIII of the Code provided the following additional requirements are complied with:

(1) The minimum thickness of shells, heads, and other pressure-containing parts shall be $^1/_4$ in. The maximum thickness of the shell and head plates shall be 2 in.

(2) The maximum operating temperature shall not exceed 650 F.

(3) The requirements of Par. UG-84 shall be met for vessels that are to operate at temperatures below —20 F.

(4) The maximum allowable stress value shall be 26,250 psi.

(5) Shell plates shall not be heated for forming to a temperature higher than 1100 F. Other parts including heads that are heated for forming to temperatures over 1100 F shall be heat-treated by the manufacturer of the head or part. Forgings shall be heat-treated by the manufacturer of the forging. Test specimens prepared from full-thickness material in its final heat-treated condition, or from full-thickness samples similarly and simultaneously treated, shall be taken from any pressure parts that have been heat-treated above 1100 F after forming.

(6) When the shell or head thickness exceeds 0.58 in., the finished vessel shall be stressed-relieved as provided in Par. UCS-56(c). The stress-relieving temperature shall be between 1000 and 1100 F.

CAUTIONARY NOTE: Filler metal deposited by nickel-molybdenum-vanadium type of electrodes can become embrittled at the above stress-relieving temperatures.

(7) Double welded butt-joints or their equivalent shall be examined radiographically for their full length as prescribed in Par. UW-51. (See Item 18 of the Reply.)

(8) Welds not fully radiographed, including welds for attaching nonpressure parts, shall be examined after the hydrostatic tests by the magnetic-particle method.

(9) The qualification of the welding procedure and the welders shall conform to the requirements of Section IX, except that the radius of the mandrel used in the guided bend tests shall be as follows:

| Thickness of Specimen | Radius of Mandrel ($B$)* | Radius of Die ($D$)* |
|---|---|---|
| $^3/_8$ in. | $1^1/_4$ in. | $1^{11}/_{16}$ in. |
| $t$ | $3^1/_2\,t$ | $4^1/_2\,t + {}^1/_{16}$ in. |

* Corresponds to dimensions $B$ and $D$ in Figs. Q-8 and QN-8, Section IX; other dimensions to be in proportion.

A separate welding procedure shall be made for this material.

(10) All main welded joints including welds for nozzle attachment shall be of the double-welded butt type or their equivalent. Where a backing strip is used, it shall be removed and the joint shall be examined by the magnetic-particle method prior to the required full radiographing. All openings regardless of size shall meet the requirements for reinforcing.

(11) All parts shall be made of the material specified in the Inquiry, except that pipe flanges or pipe of carbon steel may be welded to nozzle necks of the material specified in the Inquiry provided the butt weld is located more than a distance equal to the square root of $r \times t$ measured from the face of the reinforcement, where $r$ = the inside radius of the nozzle neck and $t$ = the thickness of the nozzle at the surface of the vessel or reinforcing plate if one is used. The design of the nozzle neck shall be made on the basis of the allowable stress value of the weaker material.

(12) Structural attachments of other steels shall not be welded directly to shells or heads of material specified in the Inquiry.

(13) Conical sections shall be provided with a skirt having a length not less than $0.50\sqrt{rt}$ (where $r$ is the inside radius of the adjacent cylinder and $t$ is the thickness of the cone), or $1^1/_2$ in., whichever is larger. A knuckle shall be provided between the skirt and the cone; the knuckle radius shall be not less than 6 per cent of the outside diameter of the skirt but in no case less than three times the cone thickness.

(14) The longitudinal joint alignment shall not exceed 20 per cent of the nominal plate thickness, or $^3/_{32}$ in., whichever is less, instead of the values prescribed in Par. UW-33.

(15) The circumferential joint-alignment tolerances shall be as follows, instead of the values prescribed in Par. UW-34:

| | |
|---|---|
| For plates up to and including $^3/_4$ in. in thickness | 20 per cent of nominal plate thickness |
| For plates over $^3/_4$ in. and up to and including $1^1/_2$ in. in thickness | $^3/_{16}$ in. |
| For plates over $1^1/_2$ in. in thickness | $12^1/_2$ per cent of nominal plate thickness but not to exceed $^1/_4$ in. |

(16) When repairs have to be made to welded joints, the repair procedure shall be qualified in accordance with the original welding procedure, subject to the stipulation that cutting and gouging processes to be employed in the repair work shall be included as part of this procedure qualification.

(CAUTIONARY NOTE: The properties of the base metal may be adversely affected by excessive local heat inputs.)

(17) When hemispherical heads are used, the head-to-shell transition of Fig. UW-9, sketch (c), shall be used. When the weld is in or adjacent to the tapered section it shall be finished in a manner that will maintain the required uniform slope for the full length of the tapered section.

(18) The requirements of Pars. UW-35(a) and UW-51(b) shall be met except that the maximum finished weld reinforcement shall not exceed 10 per cent of the plate thickness, or $^1/_8$ in., whichever is less. (This joint surface finish is necessary for this material to minimize strain intensification, in addition to providing for satisfactory radiographs.)

(19) Welds for pads, lifting lugs, and other nonpressure parts, as well as temporary lugs for alignment, shall be made in full compliance with a welding procedure qualified in accordance with Section IX. Temporary welds shall be removed, the area shall be inspected for damage, and the metal surface shall be restored to a smooth contour. If repair welding is required, it shall be qualified in accordance with Item (16) of the Reply.

(20) Steel stamping of all types may be omitted on plates below $^1/_2$-in. thickness. Other markings used in lieu of stamping to identify material shall be legible on the completed vessel until final acceptance by the authorized inspector.

### Case No. 1227
### (Special Ruling)

*Inquiry:* May bolting including studs and nuts of alloy material as specified in the Reply be used for temperatures up to 500 F, inclusive, for unfired pressure vessels in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code?

*Reply:* It is the opinion of the Committee that bolting including studs and nuts of material as specified below may be used for temperatures up to 600 F, inclusive, for unfired pressure vessels in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.

A maximum allowable stress value of 20,000 psi may be used up to 600 F, inclusive.

Material shall conform to the following requirements as to chemical composition, heat-treatment, and mechanical properties:

CHEMICAL COMPOSITION

| | PER CENT |
|---|---|
| Carbon, max | 0.07 |
| Manganese, max | 1.00 |
| Phosphorus, max | 0.04 |
| Sulfur, max | 0.03 |
| Silicon, max | 1.00 |
| Chromium | 15.50–17.50 |
| Nickel | 3.00– 5.00 |
| Copper | 3.00– 5.00 |
| Columbium plus tantalum | 0.25– 0.45 |

HEAT-TREATMENT. Material shall be solution heat-treated at 1900 F plus or minus 25 F, and shall then be aged at 1150 F plus or minus 50 F for four hours and then air cooled.

MECHANICAL PROPERTIES OF BOLTING:

| Ult. Tens. Str., psi Min | 0.2 Per Cent Yld Str., psi Min | Elong. $4 \times D$ Per Cent, Min | Red. Area Per Cent, Min |
|---|---|---|---|
| 135,000 | 100,000 | 15 | 50 |

MECHANICAL PROPERTIES OF NUTS: Hardness Min (All Sizes)—

Brinell 277
Rockwell C28

OTHER REQUIREMENTS. All other requirements shall be in accordance with SA-193 and SA-194 insofar as applicable.

### Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

AS NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.

### Low-Pressure Heating Boilers

PAR. H-13 Put entire paragraph as a footnote under Table H-2.

Add a new Par. H-13 as follows:

H-13(*a*) Plain horizontal cylindrical furnaces or flues shall conform to the following:

(1) The thickness of the furnace wall shall be not less than $^5/_{16}$ in. and not more than $^{13}/_{16}$ in.

(2) The design temperature of the furnace shall be taken as 500 F.

(3) The thickness of the furnace wall shall be determined by the use of Fig. H-1. The notations defined below and shown in Fig. H-1 are used in the formulas of this paragraph.

$t$ = minimum required wall thickness of furnaces or flues, in.
$L$ = design length of furnace taken as the distance from center to center of weld attachment, in.
$D_o$ = outside diameter of furnace or flue, in.
$P$ = design pressure, psi.

The required wall thickness of the furnace or flue shall be not less than determined by the following procedure:

*Step 1:* Assume a value for $t$. Determine the ratios $L/D_o$ and $D_o/t$.

*Step 2:* Enter left-hand side of Fig. H-1 at value of $L/D_o$.

*Step 3:* Move horizontally to the line representing $D_o/t$ determined in Step 1 (for intermediate $D_o/t$ ratios, interpolations shall be made between the lines on the chart in Fig. H-1).

*Step 4:* From this intersection move vertically to the material line of the proper temperature.

*Step 5:* From this intersection move horizontally to the right and read the value of $B$.

*Step 6:* Compute the allowable working pressure $P_a$ by the following formula:

$$P_a = \frac{B}{D_o/t}$$

*Step 7:* Compare $P_a$ with $P$. If $P_a$ is less than $P$, a greater value of $t$ must be selected to increase $P_a$ so that it is equal to or greater than $P$.

(*b*) Furnaces or flues shall be rolled to practically a true circle with a maximum deviation from the true circle of not more than $^1/_4$ inch.

(*c*) Corrugated and ring-reinforced furnaces shall be designed in accordance with Section I, Power Boilers. Stress relieving is not required for such furnaces constructed under the requirements of Section IV.

FIG. H-1 Add a new Fig. H-1. (Copies of this chart may be obtained on request from the Secretary of the ASME Boiler and Pressure Vessel Committee, 29 West 39th St., New York, N. Y.)

# Roundup

## Of Current Engineering Events, News, and Comment

**E. S. Newman, *News Editor***

**First Kettering Award goes to Charles F. Kettering, Fellow ASME, noted inventor. The Award is sponsored by the Civil, Mining, Mechanical, Chemical, Automotive, and Electrical Engineering Societies. It was presented to Dr. Kettering on Thursday, October 4, at a special luncheon during the fall general meeting of the American Institute of Electrical Engineers at Chicago, Ill. *Left to right:* E. G. Bailey, past-president and Fellow ASME, founder and chairman of the Bailey Meter Company, M. S. Coover, president of AIEE, Dr. Kettering, and A. A. Potter, past-president and Hon. Mem. ASME, of Purdue University.**

## Six Engineering Societies Join to Honor C. F. Kettering

CHARLES F. KETTERING, Fellow ASME, director and former vice-president of General Motors Corporation, was honored on October 4 by the six leading engineering societies when he was presented with an award at a luncheon held during the fall general meeting of the American Institute of Electrical Engineers in Chicago, Ill.

### Kettering Award Sponsors

The award, which is called the Charles Franklin Kettering Award, is sponsored by the American Society of Civil Engineers, the American Institute of Mining, Metallurgical, and Petroleum Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, and the Society of Automotive Engineers. This was the first time the award has been presented. It is planned that it will be made annually to an outstanding engineer "for creative accomplishments for the benefit of mankind, including discovery, invention, improvement in designs or processes within the relationship of materials and energy."

### Leaders Laud Dr. Kettering

M. S. Coover, president of AIEE, introduced the heads of the other five societies and honored guests. Dean A. A. Potter, past-president and Hon. Mem. ASME, of Purdue University described Dr. Kettering as "one of the most useful leaders of our times," and said that this award was a means of honoring the inventor of the automobile self-srarter by his friends and associates. To determine future recipients a yardstick of achievement is needed and Dr. Kettering is this measure.

E. G. Bailey, past-president and Fellow ASME, founder and chairman of the Bailey Meter Company, and director of The Babcock and Wilcox Company, told some of the high lights of Dr. Kettering's career, starting with his first job with the National Cash Register Company, when he electrified the cash register in 1904. In 1919 he began his life-long connection with General Motors Corporation, of which organization he is still a director and consultant. Mr. Bailey said that Dr. Kettering's greatest contribution was his keen mind in determining today's problems.

Coincidental with the establishment of this award, Mr. Bailey said a book entitled "Professional Amateur, Charles Franklin Kettering," by T. A. Boyd, is to be published. He highly recommended the book as a help in the better performance of any assignment whether it be in education, research, invention, management, or sales.

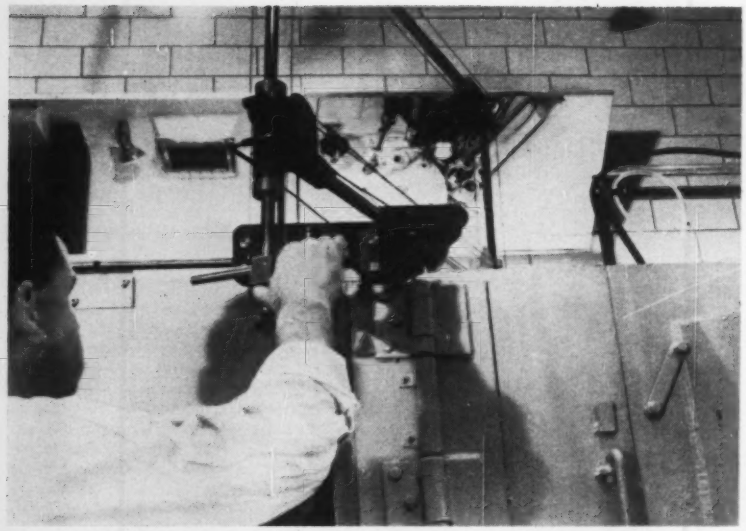
D. P. Barnard, a past-president of the Society of Automotive Engineers, presented the award to Dr. Kettering. This read, "For pioneering inventions in the fields of applying materials and energy to practical uses, for stimulation of the inventive ideal in thousands of engineers and scientists, for contributions to our national defense, for enlarging the cooperation between industry, research, and education, for enthusiastic selfless dedication to human relations and welfare our societies have instituted The Charles Franklin Kettering Award and are now joined together to make this initial presentation to Charles Franklin Kettering," and was signed by the presidents of the six participating societies.

Dr. Kettering in his response said that he never was anything but a mechanic and inventor, whom nobody likes because he is not a specialist. He gave credit to the engineering societies because they are a means of distributing information, which is sorely needed in today's progressing world.

### Education Is too Specialized

"Education today is too specialized," said Dr. Kettering. "If a kid has any originality, it is knocked out of him in school. We want him to read only one page of the encyclopedia, when he should read the whole book. It takes several highly specialized scientists to do a job now that one fellow could do 20 years ago. The difference is that this low-grade fellow would try anything. I'm for education, but one of our greatest problems is that we try to standardize everybody. The ambition of every educator should be to educate people so that they can do anything.

"We overestimate the little that we do know and completely disregard the infinite we don't know."



**Oak Ridge National Laboratory, which Union Carbide Nuclear Company, a Division of Union Carbide and Carbon Corporation, operates for the U.S. Atomic Energy Commission, completed its first decade of radioisotope production and distribution to users in industry, medicine, and agriculture. Modern processing facilities such as the radioisotope bottling unit shown above have replaced the relatively crude equipment used 10 years ago. Since its first shipment to the Barnard Free Skin and Cancer Hospital, St. Louis, Mo., Aug. 2, 1946, the Laboratory has experienced a phenomenal growth. Over 1100 radioisotope shipments are now made each month to 2700 users throughout the United States and 57 foreign countries.**

# Oak Ridge National Laboratory Completes First Decade of Radioisotope Production and Distribution

Another milestone in the atomic age was passed in August when Oak Ridge National Laboratory announced the completion of its first 10 years of producing and distributing radioisotopes for use in medicine, industry, and agriculture. The Laboratory, which is operated for the Atomic Energy Commission by Union Carbide Nuclear Company, a Division of Union Carbide and Carbon Corporation, made its first shipment of a fission-produced radioisotope on Aug. 2, 1946. The shipment consisted of a small unit of Carbon-14 which went to the Barnard Free Skin and Cancer Hospital in St. Louis, Mo.

By the end of the Laboratory's first year, over 280 shipments had been made to 83 institutions which used them primarily in fundamental research work. Today, over 2700 users throughout the United States and 57 foreign countries receive radioisotopes produced at the Laboratory. The shipments made each month amount to nearly five times the number made during the program's entire first year of operation. In all, a total of over 85,000 units have been distributed by the Laboratory since the program's inception in 1946.

The Atomic Energy Commission's radioisotope program at Oak Ridge National Laboratory has fostered and introduced a new phase of American industry. Estimates of the total savings to industry alone resulting from radioisotope applications have been placed at over $200 million annually. Radioisotopes are being used in radiography and radiation-damage studies by industry and for many other purposes, such as "tagging" chemical compounds, mechanical-wear tests, and radiation chemistry research. Because of their unique characteristics, they have opened new doors in medical and biological research.

To cope with the increasing demand for radioisotopes, the Laboratory has had to expand its facilities several times during the past 10 years. From relatively crude facilities have come modern processing units capable of producing highly refined radiochemicals in quantities undreamed of a decade ago.

Nearly 100 different radioisotopes are now available from the Laboratory. Many commercial firms purchase radioisotopes in bulk quantities and reprocess them into such forms as labeled compounds, certified pharmaceuticals, and custom-manufactured radiation devices. Thus a single large unit of radioactivity from the Laboratory may represent hundreds of shipments to individual licensed customers.

Although several other AEC laboratories are now distributing radioisotopes, the Laboratory remains the primary source.

## U. S. National Museum to Enlarge Hall of Tools Exhibit

The United States National Museum at Washington, D. C., is engaged in enlarging its collections and exhibits for its new Hall of Tools. It is planned to have a series of historical exhibits showing the development of hand tools, mechanical tools, power tools, precision tools, and automatic tools.

The museum would like to obtain originals, models, or replicas of old tools that would be included in these categories, especially of those tools which mark a fundamental advance in the development of tools. Tools of which the date and maker can be adequately documented are especially desired. It would also like to obtain drawings, photos, plans, and so on, of old tools, as well as collections of professional papers, photos, and the like, of men and firms who played important parts in the development of the tool industry.

The museum would also be interested in obtaining similar material for first development models of new tools which promise to be of historical significance.

The aims of the museum in these collections are to make possible adequate and correct recording of the history of the tool industry, and in its exhibits to demonstrate to the public the central place held by tools and the men who invented and made them in the development of our industrial society.

Address all replies to: Robert S. Woodbury, Curator, Division of Engineering, U. S. National Museum, Smithsonian Institution, Washington 25, D. C.

## Meetings of Other Societies

**November 7–9**
Society of Rheology, annual meeting, Mellon Institute and Webster Hall Hotel, Pittsburgh, Pa.

**November 13–15**
Investment Casting Institute, fourth annual meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

**November 25–28**
American Society of Refrigerating Engineers, semi-annual meeting, Hotel Statler, Boston, Mass.

**November 28**
American Iron and Steel Institute, regional technical meeting, Hotel William Penn, Pittsburgh, Pa.

**December 3–5**
Air Pollution Control Association, semi-annual meeting, Rice Hotel, Houston, Texas

**December 5–7**
American Institute of Mining and Metallurgical Engineers, electric furnace steel conference, Hotel Morrison, Chicago

**December 9–12**
American Institute of Chemical Engineers, annual meeting, Statler Hotel, Boston, Mass.

**December 9–12**
American Society of Agricultural Engineers, winter meeting, Edgewater Beach Hotel, Chicago, Ill.

**December 10–12**
American Nuclear Society, winter meeting, Sheraton-Park Hotel, Washington, D. C.

*(ASME Coming Events, see page 1083)*

## AEC Technical Information Service Announces Reference Center

THE Technical Information Service recently announced the organization of a complete reference center which includes a master card catalog of all classified and unclassified reports and engineering materials released into the Civilian Application Program. This centralized information resource is located in Oak Ridge and is available to all access-permit holders in accordance with the approved scope of information authorized in individual access agreements.

To facilitate use of this information collection, separate report files have been established for Secret, Confidential, and Unclassified information. Classified materials consist of information announced in special bibliographies, abstract journals, and announcement bulletins prepared for the Civilian Application Program. The unclassified segment of this center includes a complete collection of AEC unclassified research and development reports.

Individual card catalogs have also been organized for Secret, Confidential, and Unclassified report materials. These catalogs make it possible to locate technical information in report literature by any or all of the four methods which have been found most useful: by technical subject; by report number; by originating organization; and by personal author.

This library is maintained by the Technical Information Service Extension in Room 130 of the AEC Administration Building, Oak Ridge, Tenn., and is open from 9:00 a.m. to 4:00 p.m., Monday through Friday.

Requests for visit-approval forms should be submitted through the AEC office administering your access permit. If your permit authorizes access to secret information, please indicate clearly the specific categories approved.

# Monsanto Meeting Discusses Mechanical Engineers' Place in Chemical Industry

MECHANICAL-ENGINEERING professors from 11 colleges and universities were recent guests of Monsanto Chemical Company plants and laboratories in two Massachusetts cities. The two-day visit was part of Monsanto's continuous program to acquaint educators with the chemical industry and its manpower requirements.

On October 2, the 11 professors visited the Springfield plant of the firm's Plastic Division; the next day they visited the Everett plant of the Inorganic Chemicals Division.

Although professors of chemistry and chemical engineering frequently have visited Monsanto installations under the program, mechanical-engineering professors participated this year for the first time.

### Employment Opportunities

Believing that employment opportunities in the chemical industry are often overlooked by mechanical-engineering graduates, Monsanto hoped that a review of those opportunities with the professors would help spark new interest.

Included on the two-day agenda were talks by Monsanto personnel, panel discussions in which the educators participated, and tours of the company's plant and laboratory facilities.

Spokesmen for Monsanto's engineering, production, research, and sales departments described how mechanical engineers already are contributing to their respective operations and indicated the firm's projected needs for such specialists. Tours were planned to highlight these same needs.

### Industry and Education Meet on Manpower Problems

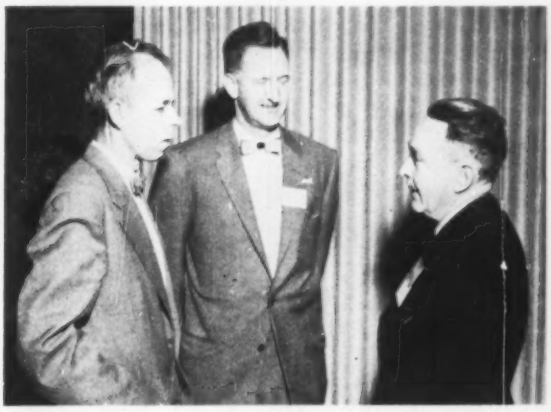
Monsanto-sponsored informational meetings with technical educators were originated by Francis J. Curtis of St. Louis, Mo., Monsanto vice-president for personnel. Mr. Curtis believes American industry has an obligation to keep academic leaders apprised of its objectives, problems, and manpower requirements to serve as guideposts in the training of technical personnel.

Mr. Curtis refers to the systematic interchange of information and counsel as Monsanto's "two-way-street" program. It has been operative for several years under his guidance.

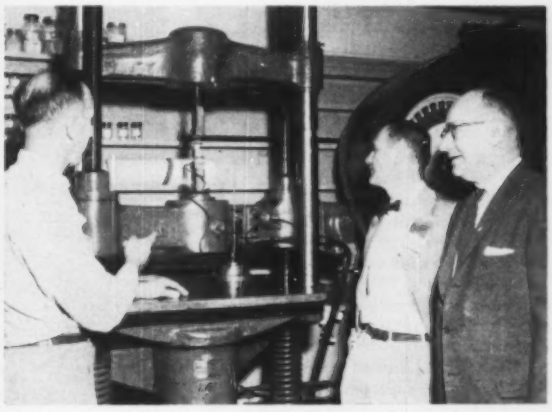
### Professors Who Attended

Mechanical-engineering professors who attended the Springfield-Everett meetings included:

C. L. Brown, Assoc. Mem. ASME, Purdue University, J. J. Devine, Rensselaer Polytechnic Institute; W. B. Diboll, Washington University; J. H. Dittfach, University of Massachusetts; G. M. Dusinberre, Fellow ASME, Pennsylvania State University; A. J. Miles, Mem. ASME, Missouri School of Mines; W. M. Murray, Massachusetts Institute of Technology; D. F. Livermore, Mem. ASME, University of Wisconsin; H. B. Phelps, Clarkson College; C. W. Reisse, Drexel Institute of Technology; and F. L. Schwartz, Mem. ASME, University of Michigan.



**R. L. Miller, manager of Monsanto Chemical Company's Everett plant, discusses the chemical industry's need for mechanical engineers with two of the 11 mechanical-engineering professors who visited the plant October 4. *Left to right* are Prof. J. H. Dittfach, University of Massachusetts, Mr. Miller, and Prof. G. M. Dusinberre, Fellow ASME, Pennsylvania State University.**



**A Monsanto researcher, *left,* explains how physical testing equipment is utilized at the company's Springfield, Mass., laboratories. Visiting mechanical-engineering professors are W. B. Diboll, *center,* Washington University, and A. J. Miles, Missouri School of Mines. Visit is part of Monsanto's program to acquaint educators with chemical industry and its manpower requirements.**

# Mayor Wagner Proclaims Nov. 26–30 "Automation Week" in New York City

*New York will be the automation capital of the world for a week this month. Outstanding events include ASME Annual Meeting, Power Show, International Automation Exposition, and various other conferences*

Mayor Robert F. Wagner of New York City has officially proclaimed the week of November 26 to November 30, the week after Thanksgiving, as Automation Week.

Lending substance to the spirited words of the proclamation is a varied line-up of events which will attract specialists in automation from all parts of the world. Among the important events is the Third International Automation Exposition, to be held at the new Trade Show Building, 500 Eighth Avenue.

It was the Second International Automation Exposition, held last year at Chicago's giant Navy Pier, that attracted Russian experts on mass production. The return visits of ASME automation experts led to a series of exchange invitations which has not yet run its course.

Apart from the International Automation Exposition, but sponsored by and co-ordinated with it, are two conferences, one on Automation for the Office and the other on Human Engineering for Automation. The former is cosponsored by Fordham University School of Business and the latter cosponsored by Manhattan College. A hundred "clinics" in different aspects of automation, using exhibits at the exposition as demonstration material, are scheduled for Automation Week. Capping the climax, the Annual Meeting of The American Society of Mechanical Engineers will convene the same week, at the Statler and McAlpin Hotels, attracting additional thousands of engineers.

# Second NYU Titanium School Attracts International Students

Technological optimism marked the second annual titanium program at the New York University College of Engineering, Sept. 10–14.

The program continued its classroom format though, on the basis of a questionnaire at the first conference, examinations were eliminated this year.

One conspicuous "student" this year was S. A. Samarin, leading Soviet Russian steelmaking authority. Mr. Samarin is deputy director of the Soviet Institute of Metallurgy and a member of the Academy of Sciences in Moscow. In private conversations, he is said to have reported considerable progress in titanium research and development in Russia. Some delegates were frankly dubious about his claims while others adopted a wait-and-see attitude.

## Titanium Sales Double

Keynoting the conference was a forecast by Francis C. Frary of the Materials Advisory Board of the National Research Council, that this year's titanium sales should more than double last year's. (Dr. Frary could not attend because of illness and his paper was presented by Prof. H. C. Kellogg of Columbia University.)

"This increased demand is very important," said Dr. Frary, "since practical experience is the only means by which fabricators can solve their production problems and learn how to make sheet, rod, forgings, and tubing of consistently high quality at lower cost."

The noted British titanium authorities, Dr. and Mrs. Allan D. McQuillan, were among the featured speakers.

Dr. McQuillan, from the University of Birmingham, discussed the undesirable effects of hydrogen in titanium alloys. Considerable research done on the effect of hydrogen in steels and nickel unfortunately has no relevance to titanium, he noted.

"Hydrogen present in titanium must be considered as an alloying element since it is capable of forming extensive solid-solutions in both forms of titanium at elevated temperature. At elevated temperature a hydrogen-titanium alloy will attempt to create around it a hydrogen atmosphere at a pressure which will depend on the temperature of the material and the amount of hydrogen present in the metal."

Despite the novelty of titanium-hydrogen problems, he said, the process of hydrogen absorption and evolution can be treated by methods of thermodynamics.

Mrs. McQuillan, who works for Imperial Chemical Industries, discussed the interstitial elements oxygen, nitrogen, and carbon.

About 185 metallurgists and engineers attended the NYU program. According to John P. Nielsen, chairman of NYU's department of metallurgical engineering, interest in the program is such that it will be held again next year. Next year will also probably see publication of the papers, Dr. Nielsen added.

## Titanium in Aircraft Industry

Although titanium is still used primarily in the aircraft industry, several speakers discussed the rising industrial applications. Dwight W. Kaufmann, of Rem-Cru Titanium, Inc., stated, "Even at today's prices titanium is being used in a rapidly increasing number of applications because it is cheaper than some of the more common materials." He said more than 10,000 tons of titanium-mill products will probably be shipped during 1957, twice as much as this year's shipments.

Earlier, Dr. Frary had pointed to some of the bottlenecks. Most production of semi-fabricated forms of titanium (sheet, rod, forgings, extrusions), for example, has been done on machinery designed and used for working of alloy steel, bronze, or aluminum, he noted. "Undoubtedly better results in both quality and costs could be obtained with equipment designed for titanium. But such equipment represents a heavy investment which the present volume of production does not justify."

**S. A. Samarin, leading Soviet steelmaking authority, *left,* discusses technical problem with John P. Nielsen, chairman of the department of metallurgical engineering at New York University. Mr. Samarin, who is deputy director of the Soviet Institute of Metallurgy, attended the second annual titanium conference at the NYU College of Engineering, September 10 to 14. He is also a corresponding member of the Academy of Sciences, Moscow.**

Some hints that completely new extraction methods may be on the horizon came from Polykarp Herasymenko of NYU. The decision to expand the Kroll method to an industrial scale was quite correct, he said, but the matter is not settled at that. "The human mind is restless, speculative, and inventive and always tries to improve already known methods and to invent completely new ones... This also holds true for the production of titanium metal." Methods Dr. Herasymenko discussed included electrolytic, reduction by hydrogen, reduction with metals, electrolysis of titanium halides, and electrolysis with soluble anodes.

Other topics at the NYU conference included arc and vacuum melting, casting, phase diagrams, metallography, the influence of microstructure and composition on properties of alpha-beta alloys, practical heat-treatment of alloys, and the use of titanium metal in jet engines.

# M.I.T. Students First to See Impact-Extrusion Processes

## *Sun Tube Corporation shows future engineers practical uses of extrusion processes*

For the first time, engineering students are being given an opportunity thoroughly to familiarize themselves with the intricacies and techniques of the versatile and growing impact-extrusion process through field trips to the Sun Tube Corporation's impact-extrusion plant, Washington, N. J.

Appropriately enough, the first such trip was made September 13 by a group of 30 students from the Massachusetts Institute of Technology at the invitation of an M.I.T. alumnus, Kenneth M. Leghorn, president of Sun Tube.

### Students Shown Impact Extrusion in Use

The decision to introduce engineering students to impact extrusion—and vice versa—breaks with general practice in this burgeoning industry. The scope of the process has been growing so fast, and new developments are turning up at such a rate, that producers of impact extrusions have been playing it very close to the vest. Like Macy's, they haven't been telling Gimbel's, or anyone else.

On the other hand, the speed of development has been, in one way, a disadvantage to the impact extruders, in that they have difficulty in keeping design engineers abreast of the increasing capabilities of the process.

It was this, combined with the fact that in most engineering textbooks impact extrusion still receives only a paragraph or two, that decided Mr. Leghorn to make Sun Tube's methods and know-how available to interested students. He reasoned that the student who learns of the uses and potentialities of impact extrusion today will be the graduate engineer who keeps them in mind tomorrow.

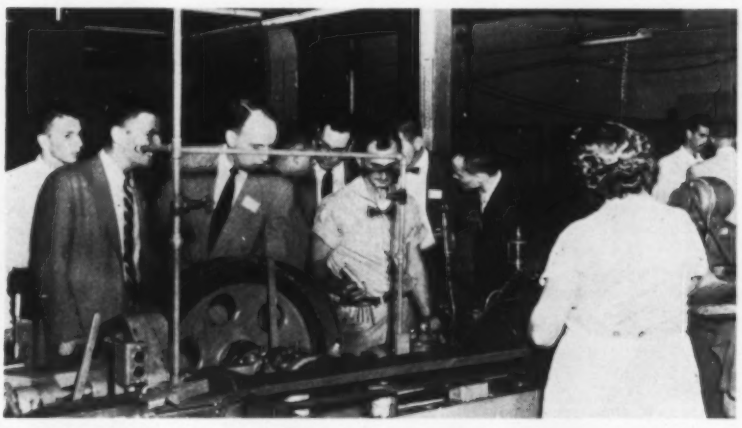
That this program is sound was borne out during a briefing of the students before touring the plant. Nicholas Marschak, Sun Tube's chief engineer, prefaced his explanation of the process with two questions. First, he asked how many of the students had previously heard of impact extrusion and 14 hands went up. Then he asked how many understood it. Two men responded. And one of these, as he lowered his hand, was heard to remark "I *think* I do...."

### Plant Tour

Consequently, the plant tour came as somewhat of a revelation to the future engineers. They saw cold-worked aluminum parts and components being made in an enormous range of shapes and sizes, from three-sixteenths of an inch in diameter to three and one-half inches, and from three-quarters of an inch to 14 inches in length. Design modifications included fluting, bosses, shoulders, internal and external lugs, thin walls and thick bottoms, thick walls and thin bottoms, and double and triple-wall designs—all produced complete in a split second on high-speed automatic impact-extrusion presses.

The students were also shown specific examples of industrial substitutions of impact-extruded parts for machined and multiple-part assemblies—substitutions which have materially cut costs, simplified assembly, and strengthened the whole product.

At the end of the tour, each student received a box of typical impact extrusions for further study, and a specially prepared, illustrated 28-page data book on the technical aspects and applications of the process. This book will be distributed to subsequent student groups and also will be made available to engineering departments in colleges and universities throughout the country as a supplement to current texts.



**M.I.T. metallurgy students and Sun Tube Corporation engineers inspecting an automatic impact-extrusion line at the company's plant in Washington, N. J., on a recent inspection tour. The impact extrusion the mechanic is holding, produced on this line, is a seamless, one-piece hydraulic cylinder with fluted sides and a complex bottom. It is produced complete with one stroke of the impact-extrusion press, requiring only trimming and piercing.**

## People

***Honors and Awards.*** William Frederick Durand, past-president and Hon. Mem. ASME, and at ninety-seven the oldest living graduate of the United States Naval Academy, finally got his diploma on Sept. 5, 1956, 76 years after he was graduated from Annapolis. In 1880 when Dr. Durand was graduated, the Academy did not award degrees, and although Congress made all past and future graduates eligible for Bachelor of Science degrees in 1933, he never applied. Naval Academy alumni thought he should have it anyway, and arranged the special ceremony at the Mohawk Hotel in Brooklyn, N. Y. Other honors bestowed on Dr. Durand, whose innovations in aerodynamics are well known, include a doctorate in engineering earned in 1887 at Lafayette College in Easton, Pa.; directorships of the Cornell University Graduate School of Naval Architecture and Marine Engineering, and of the Mechanical Engineering Department at Stanford University; as well as the chairmanship during World War II of the Engineering Division of the National Research Council.

The following members of ASME were elected Honorary Members of the Society: Charles W. E. Clarke of Philadelphia, Pa.; William Francis Gibbs, New York, N. Y.; and Solomon C. Hollister of Ithaca, N. Y.

**John M. Ferry, Mem. ASME, Special Assistant for Installations to the Secretary of the Air Force, Donald A. Quarles, was presented with the Exceptional Civilian Service Award at a noon ceremony, September 5, in the Pentagon. *Left to right,* Mr. Quarles, who made the presentation, Mr. Ferry, Under Secretary J. H. Douglas, Jr., General Nathan F. Twining.**

HARRY F. VICKERS, Mem. ASME, president of the Sperry Rand Corporation, has been named recipient of the ASME Medal. He was cited in particular for "Pioneering in industrial oil hydraulics and for notable accomplishments in business leadership." He holds 95 patents covering hydraulic and other devices.

BEN MORELL, distinguished engineer and noted officer, builder of naval works in war and in peace; eminent industrialist and civic leader, has been chosen recipient of the 1957 John Fritz Medal.

HENNING W. PRENTIS, JR., chairman of the board, Armstrong Cork Company, Lancaster, Pa., has received the 1956 Henry Laurence Gantt Gold Medal for "distinguished achievement in industrial management as a service to the community."

FREDERICK BRANT RENTSCHLER has been awarded the Daniel Guggenheim Medal for 1956, for "a wide range of major achievements throughout a lifetime devoted to aviation with specific reference to his many notable contributions to the vital aircraft-engine field."

CARL F. KAYAN, Member ASME, department of mechanical engineering at Columbia University, and visiting professor this past year at the Royal Institute of Technology in Sweden, has recently been elected honorary vice-president of the John Ericsson Society of New York. Professor Kayan was one of the numerous American engineers presenting papers at the ninth International Congress of Applied Mechanics in Brussels, Belgium, in September, and was the U. S. A. observer at the Louvain and Zurich meetings of the International Institut du Froid.

The Hoover Medal for 1956 will be presented to HERBERT HOOVER, JR., Under Secretary of State. The medal is named after his father who was the first recipient in 1930, and this is the first time in the 86-year-old history of the 26,000-member AIME that there has been a father and son achievement of so high an award. Sponsored by four Founder Societies, the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, the medal is awarded "by engineers to a fellow engineer for distinguished public service."

JAMES O. JACKSON, whose outstanding record in engineering research led him to the vice-presidency and a directorship in the Pittsburgh-Des Moines Steel Company, was the 1956 winner of the Marston Medal at Iowa State College.

The American Society of Civil Engineers has announced the first winners of two new awards. RALPH E. BOECK, of the department of civil engineering, Marquette University, was named first recipient of the ASCE Ernest E. Howard Award; and ALLEN J. CURTIS, Assoc. Mem. ASME, of Culver City, Calif., lecturer in engineering at the University of California, Los Angeles, and FRANK E. RICHART, JR., of the department of civil engineering, University of Florida, at Gainesville, sharing the Thomas A. Middlebrooks Award.

FLOYD A. FIRESTONE, consulting physicist, prolific inventor, technical educator and editor, received the Edward Longstreth Medal of The Franklin Institute of the State of Pennsylvania. The award was made at the Institute's annual medal day ceremonies, Wednesday, October 17.

ARTHUR W. BURKS, professor of philosophy, University of Michigan; CARL H. POLLMAR, associate research mathematician and lecturer, University of Michigan; DON W. WARREN, research mathematician, University of Michigan; JESSE B. WRIGHT, research mathematician, University of Michigan; and ROBERT MCNAUGHTON, department of philosophy, Stanford University, were honored "in recognition of their paper, 'The Folded Tree' appearing in the July and August, 1955, issues of the *Journal of The Franklin Institute*," according to the citation accompanying the Louis E. Levy Medal award.

FREDERICK S. BLACKALL, JR., past-president and Fellow ASME, president and treasurer of the Taft-Peirce Manufacturing Company, received the Howard Coonley Medal for "great service in advancing the national economy through voluntary standards," at an award luncheon, October 24, during the seventh National Conference on Standards of the American Standards Association at the Hotel Roosevelt, New York, N. Y. On the same occasion CHARLES RUFUS HARTE, construction engineer of the New York, New Haven and Hartford Railroad Company, received the Standards Medal, awarded annually for leadership in the development and application of industrial standards.

ALFRED M. FREUDENTHAL, Mem. ASME, professor of Civil Engineering at Columbia University, has been awarded the 1956 Medal of the Swedish Aeronautical Society. The presentation was made recently by Bo Lundberg, president of the Swedish Society of Engineers, at the Swedish Aeronautical Research Institute in Stockholm.

GLENN B. WARREN, Fellow ASME, vice-president and general manager of General Electric Company's Turbine Division, has received an honorary DS degree from Union College in recognition of his achievements in the field of turbine engineering.

HENRY T. HEALD, Mem. ASME, who left the presidency of New York University October 1 to become head of the Ford Foundation, received the honorary degree of Doctor of Civil Law from the university.

HENRY BIGELOW OATLEY, Fellow ASME, consultant and retired vice-president of engineering, The Superheater Company, New York, N. Y., was elected to honorary membership in the American Society for Testing Materials.

Award of the first Member-for-Life Fund Medal of the American Institute of Electrical Engineers to F. E. TERMAN, provost and dean of the School of Engineering, Stanford University, was made during the fall general meeting of the AIEE at Chicago, Ill.

LESTER M. GOLDSMITH, Fellow ASME, has been honored by the Atlantic Refining Company for the completion of forty years of service with the company. He is general manager of the company's engineering and construction department.

Seven leaders in the metals field were honored by the American Society for Metals, with awards presented during the 38th National Metal Exposition and Congress held at Cleveland, October 8–12. EDGAR H. DIX, JR., assistant director of research at the Aluminum Company of America's Aluminum Research Laboratories at Pittsburgh, Pa., received the Albert Sauveur Achievement Award. WILLIAM H. EISENMAN, for more than 39 years national secretary of the ASM, was chosen by society trustees for the ASM Gold Medal. CHARLES M. WHITE, recently elevated from the presidency to the board chair-

manship of Republic Steel Corporation, received the ASM's Research Medal. Three scientists shared the ASM's Henry Marion Howe Medal Award: ALEXANDER R. TROIANO, professor and head of the Department of Metallurgy at Case Institute of Technology, Cleveland; WILLIAM J. BARNETT, General Electric Company, Evendale, Ohio; and RICHARD P. FROHMBERG, senior engineer, North American Aviation Corporation, Downey, Calif. ERNEST P. NIPPES, professor of metallurgy at Rensselaer Polytechnic Institute, Troy, N. Y., was given the ASM's Teaching Award for his outstanding performance in the teaching of technical men.

C. C. FRANCK, Mem. ASME, has been appointed consulting engineer at the Westinghouse Electric Corporation's Steam Division, Philadelphia, Pa. Graduated from The Johns Hopkins University, where he received the BS(ME) degree in 1926 and a master's degree two years later, Mr. Franck joined Westinghouse in 1928.

The International Management Association announced the appointment of A. L. NICKERSON, president of Socony Mobil Oil Company, Inc., New York, N. Y., as chairman of its planning council. He will head an advisory group of executives of member companies. The group was formed early this year to promote the international exchange of management information. It is an affiliate of the American Management Association, national management educational group. Also elected were 35 officers and directors of IMA.

**Presentation of the Gantt Medal, under the joint auspices of The American Management Association, Inc., and The American Society of Mechanical Engineers, was made at a luncheon, September 17, at the AMA personnel conference in New York, N. Y. *Left to right* are J. Keith Louden, Mem. ASME, vice-president and general manager, Commercial Division, York Corporation, York, Pa., who presented the recipient; J. W. Barker, ASME president and president Research Corporation; E. M. Derby, Mem. ASME, manager of management education, Metropolitan Life Insurance Company, New York, who presented the medal and certificate of award; Henning Webb Prentis, Jr., chairman of the board, Armstrong Cork Company, Lancaster, Pa., award winner; and Lawrence A. Appley, Affiliate ASME, AMA president, who presided over the luncheon.**

***Editorial.*** J. HERBERT HOLLOMON of the General Electric Research Laboratory has been named advisory editor for a new "Series on the Science and Technology of Materials" which will be published by John Wiley & Sons, Inc., of New York, N. Y.

***Engineers at Work.*** R. R. TUCKER, Mem. ASME, Mayor of the City of St. Louis, Mo., whose "unemotional engineering approach to civic problems" from implementing an effective smoke-abatement program to the job of chief executive of the city, is nationally acclaimed in the *Saturday Evening Post* article "How to Rescue a City," published August 18.

***Campus.*** ERIC A. WALKER will succeed Milton S. Eisenhower as president of Pennsylvania State University. Dr. Walker, dean of the College of Engineering and Architecture since 1951, was appointed vice-president, July 1. An electrical engineer, he came to Penn State from Harvard Underwater Sound Laboratory, where he had charge of the development of ordnance weapons.

RUFUS OLDENBURGER, Mem. and chairman-elect of the Instruments and Regulators Division ASME, joined the Purdue University faculty on September 1 as professor of engineering sciences and mechanical engineering. Mr. Oldenburger was director of research for the Woodward Governor Company. In 1954, he organized the second international conference on automatic controls, the Frequency Response Symposium of the ASME. He is the only American who was invited to give a principal address at the third meeting at the University of Heidelburg in Germany this past September and also gave the greeting of the ASME.

NEWMAN A. HALL, Mem. ASME, has been appointed professor of mechanical engineering and chairman of the department of mechanical engineering at Yale University to succeed the late Prof. W. J. Wohlenberg.

**Some of the delegates to the Ninth International Congress of Theoretical and Applied Mechanics, September, 1956, in Brussels. *Left to right* are J. B. Keller, U. S. A.; J. McNamee, Great Britain; E. Reissner, U. S. A.; E. Carafoli, Rumania; J. Kampe de Feriet, France; P. H. Schlichting, Germany; W. Prager, U. S. A.; unknown; R. E. D. Bishop, Great Britain; J. N. Goodier, U. S. A.; S. Juhasz, U. S. A.; and A. Phillips, U. S. A. In the background is a flow diagram of the organization of *Applied Mechanics Reviews.***

AUGUST J. DURELLI, Assoc. Mem. ASME, internationally known authority on stress analysis, has been appointed professor in the civil-engineering department at Illinois Institute of Technology, Chicago, Ill. He will also continue as supervisor of the stress-analysis section of the mechanical-research department at Armour Research Foundation of Illinois Institute of Technology.

NATHAN M. NEWMARK, Mem. ASME, University of Illinois research professor of structural engineering, became head of the civil-engineering department September 1. Dr. Newmark is author of more than 90 papers in the field of structures and applied mechanics, and has received numerous awards for his research contributions.

ROCKER T. STATON, JR., Assoc. Mem. ASME, associate professor of industrial engineering at the Georgia Institute of Technology, in addition to his teaching duties will also serve during the 1956–1957 academic year as assistant dean of engineering.

LINCOLN H. CLARK, professor of marketing at New York University's Graduate School of Business Administration, assumed the directorship of the Wallace Clark Center of International Management at the University on July 2.

WILLIAM GOMBERG, Mem. ASME, director of the management engineering department of the International Ladies Garment Workers Union, has been appointed professor of industrial engineering at Washington University, St. Louis, Mo.

JAMES N. MACDUFF, Mem. ASME, has been named head of the department of mechanical engineering at Duke University. He comes from Princeton University where he was associate professor of civil engineering.

***Research.*** GEORGE H. HICKOX, Mem. ASME, formerly program director for engineering sciences with the National Science Foundation, has been named director of research at the Army Corps of Engineers Research and Development Laboratories, Fort Belvoir, Virginia.

DUNCAN GARDINER, Mem. ASME, has been named director of research and development for Vickers Incorporated, Detroit, Mich.

DAVID SARNOFF, Chairman of the Board of the Radio Corporation of America, received an electronic air conditioner with no moving parts, a magnetic tape-recording system for television, and an electronic amplifier of light from company scientists to mark his 50th anniversary of service in the fields of radio, television, and electronics.

***Officers.*** ALFRED IDDLES, Fellow ASME, president of The Babcock & Wilcox Company, has been elected president for the forthcoming year of the Atomic Industrial Forum, Inc. He succeeds Walker L. Cisler, Fellow ASME, president of the Detroit Edison Company, who served as president of the Forum since that organization's inception in April, 1953.

PETER B. GORDON, vice-president of Wolff and Munier, Inc., New York, N. Y., has been nominated for the presidency of the American Society of Heating and Air-Conditioning Engineers. The report of the nominating committee also includes for first vice-president, ELMER R. QUEER, director and professor of engineering research, The Pennsylvania State University, University Park, Pa.; for second vice-president, ARTHUR J. HESS, president of Hess-Greiner & Polland, Los Angeles, Calif.; and for treasurer, CHARLES H. PESTERFIELD, professor of mechanical engineering, Michigan State University, East Lansing, Mich.

JUSTUS T. VOLLBRECHT, Mem. ASME, president of Energy Control Corp., was elected national president of the Instrument Society of America during its 11th Annual Instrument-Automation Conference and Exhibit in New York, N. Y., September 17–21. He assumes office November 1 for a one-year term succeeding Robert T. Sheen, president of the Milton Roy Company, Philadelphia, Pa.

CARLYLE M. ASHLEY, chief staff engineer at Carrier Corporation, Syracuse, N. Y., was installed as president of The American Society of Refrigerating Engineers at the society's 52nd annual meeting held at the Sheraton-Gibson Hotel in Cincinnati, Ohio.

RUDOLPH A. SCHATZEL, vice-president and director of engineering, Rome Cable Corporation, has been elected president of the American Society for Testing Metals. KENNETH B. WOODS, Purdue University, is vice-president.

RICHARD K. COOK, chief of the Sound Section of the National Bureau of Standards, has been elected president of the Acoustical Society of America for the term 1957–1958.

At the annual General Meeting of the Institute of Physics held in London, England, July 16, 1956, O. W. HUMPHREYS, the director of the General Electric Company, Ltd., in charge of research, was elected president of the institute.

WILLIAM J. DURING, president of Precision Castings Company, a Division of Harsco Corporation, Syracuse, N. Y., was re-elected president of the American Die Casting Institute for the 1957 term. C. J. SHEEHAN, Die Casting Division, Aluminum Company of America, Garwood, N. J., was elected vice-president.

LESLIE F. ZSUFFA, Colonel, QMC-USAR, Mem. ASME, consulting engineer, and director of public relations for the Georgia Institute of Technology, has been elected president of the Quartermaster Association, Atlanta Chapter, for 1956–1957.

# Annual Survey of Technical Institutes for 1955–1956

A REPORT summarizing the results of the Twelfth Annual Survey of Technical Institutes, which was made in January, 1956, has been prepared by Leo F. Smith, dean of instruction, Rochester Institute of Technology, and appears in *Technical Education News*, September, 1956. All institutions were asked to report enrollments as of Jan. 2, 1956. The present survey includes enrollments for 71 schools in the United States, two more than the number reporting a year ago. In addition, the enrollments in 11 Canadian schools are included.

The survey reveals that a total of 31,145 full-time students were enrolled in the 71 institutes reporting. This represents an increase of 16.2 per cent when compared with 26,766 reported one year ago. In addition, 36,018 part-time students were reported this year, an increase of 6 per cent over the 33,981 reported last year. The grand total of 67,163 is an increase of 10.5 per cent as compared with 60,747 reported in 1954–1955. Enrollment in the Canadian schools is not included in these comparisons.

## State and Municipal Institutes

An enrollment of 11,460 regular day students in 22 institutes is reported as compared with 11,255 in the same number of schools last year. The part-time enrollment this year is 11,090 as compared with 10,451 one year ago. This year the Williamsport Technical Institute is included in the survey for the first time.

## Privately Endowed Technical Institutes

An enrollment of 5000 regular day students is reported by 12 schools as compared with 4624 in the same institutes one year ago. The part-time enrollment of 10,033 this year compares with 8503 reported one year ago.

## Extension Divisions of Colleges and Universities

A regular day enrollment of 5123 students in extension divisions of 14 colleges and universities, as compared with 4608 in the same number of schools last year, is reported. The part-time enrollment of 9594 this year compares with 11,319 last year. This lower part-time enrollment is due in a large measure to the fact that no enrollment report was received this year from the Technical Institute and Community College of Temple University.

## Proprietary Technical Institutes

A regular day enrollment of 9414 students in the 21 schools is reported, which compares with 6153 reported by 19 schools one year ago. The part-time enrollment this year is 4404 as compared with 2800 last year.

This year enrollments from the DeVry Technical Institute, Chicago, Ill.; Industrial Trades Institute, Akron, Ohio; and Radio Electronic Television Schools, Detroit, Mich., are reported for the first time.

## YMCA Schools

The day enrollment of 148 students in two schools is reported this year which compared with the 126 reported by the same schools last year. The part-time enrollment this year was 897 as compared with 908 one year ago.

## Canadian Schools

The day enrollment for the 11 Canadian Schools reporting is 4539 students, which compares with 2648 reported by seven schools a year ago. The part-time enrollment is 11,597 as compared with 8033 last year.

This year enrollments from the École Technique, Hull, Que.; École Technique, Trois-Rivieres, Que.; Textile School, St. Hyacinthe, Que.; and Vancouver Vocational Institute, Vancouver, B. C., are included for the first time.

### Summary and Conclusions

As a result of this survey, the following general conclusions may be drawn:

1 Day enrollments have again increased significantly this year (16.2 per cent), and the part-time enrollments to a somewhat lesser degree (6 per cent). Total enrollments are up to 10.5 per cent.

2 One new municipal institute, Williamsport Technical Institute, reported this year for the first time. Three proprietary institutes, DeVry Technical Institute, Industrial Trades Institute (Akron, Ohio), and Radio Electronic Television Schools, also reported for the first time. At the suggestion of C. R. Ford, assistant director of training in the Canadian Department of Labour, several additional Canadian institutes have been included.

3 The New York City Community College of Applied Arts and Sciences in Brooklyn, N. Y., reported the largest day enrollment with 2378 students. The largest part-time and total enrollments were reported by Ryerson Institute of Technology (4274 and 6026, respectively). Others reporting large total enrollments were the Long Island Agricultural and Technical Institute at Farmingdale, 5290; Rochester Institute of Technology, 4960; Penn State Technical Institutes, 4763; and New York City Community College of Applied Arts and Sciences, 4635.

## Literature

### Air Pollution

Growing nationwide concern over the problems of air pollution is reflected in the second of a series of three reports on the subject scheduled for publication this year by The American Society of Mechanical Engineers, according to F. S. Mallette, secretary of the Committee on Air Pollution Controls of ASME.

The first, published in July, 1956, provided a list of instruments and devices useful in the study of air pollution. The current report titled "Guide to Research in Air Pollution," issued October 15, deals with current research in the field. Air-pollution control equipment of all kinds will be the subject of the third. A monthly newsletter, *Smog News*, is also published by the Committee.

Research projects described in the booklet include efforts to control impurities in automobile exhausts, development of various instruments useful in sampling and analyzing various atmospheres, measurements and analysis of dust and other impurities in the air, the influence of smog or infections in plants and animals, including humans, and related topics.

Copies may be obtained for $1.50 by writing to the Order Department, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

### Stack-Spray Dust Collectors

More material on air-pollution control is contained in this pamphlet dealing with a specific problem. Industrial users of solid fuels in urban communities faced with stricter regulation of fly ash and dust from boiler stacks during soot-blowing and fire-cleaning periods, may find this method of control useful. Available from Bituminous Coal Research, Inc., 121 Meyran Avenue at Forbes, Pittsburgh 13, Pa., at 25 cents a copy.

### Arid Lands

The American Association for the Advancement of Science has issued a volume on "The Future of Arid Lands." Representatives from 28 countries met at Albuquerque and Socorro, N. Mex., to consider the present state of research and development on arid-zone problems and to formulate recommendations for new lines of research. Thirty-four papers are grouped under the topics: "The Broad View," "Variability and Predictability of Water Supply," "Better Use of Present Resources," "Prospects for Additional Water Sources," and "Better Adaptation of Plants and Animals to Arid Conditions." Copies are available from the AAAS, 1515 Massachusetts Avenue, N. W., Washington 5, D. C., at $6.75 a copy.

### Disaster Guide

"Preparation for Peacetime and Wartime Disaster in Industry," an unprecedented guide to current thinking in industrial security, has been published as a special issue of *Civil Defender*, national civil-defense magazine.

Included are articles by 30 authors who could reasonably be said to be the top authorities on plant security, emergency administration, and disaster control.

Single copies of "Preparation for Peacetime and Wartime Disaster in Industry" are available from the publisher at $1 per copy, but bulk rates for the purchase of copies in quantity are available on request. Inquiries should be addressed to: Civil Defender, Box 1641, Mobile, Ala.

## Coming Meetings

### Automation

An Office Automation Conference cosponsored by Fordham University School of Business and a Human Engineering Conference cosponsored by Manhattan College School of Engineering with Richard Rimbach Associates will be held during the Third International Automation Exposition at the Trade Show Building in New York, N. Y., November 26–30.

Gordon L. Mattson, office automation consultant, will manage the Office Automation Conference whose objective is to provide top management with information to guide them in making use of automation in data processing and the many other kinds of office work where the revolutionary techniques are applicable.

Objective of the Human Engineering Conference is to provide top management with essential knowledge of the design of systems for human use, and especially, of the relationship between automation and the individual.

Exhibits at the exposition will provide the "show how" for both conferences. Products on display will include all equipment and components necessary to "automate" any process in office or plant—from automatic assembly, handling and data-processing equipment, to subminiature relays and switches.

Complete details concerning registration and schedule of the eight sessions will be mailed to interested persons upon request from Richard Rimbach Associates, Inc., 525 Lexington Avenue, New York 17, N. Y.

### Management

Application of scientific management to cost control will be the subject of a Cost Control Conference to be held at Illinois Institute of Technology, Chicago, Ill., December 6–7.

The conference is the ninth in a series devoted to time study, materials handling, wage incentives, work and measurement study, quality control, methods improvements, systems and procedures, and similar subjects.

It is being sponsored by Illinois Tech's industrial-engineering department and National Center for Education and Research in Dynamic Equipment Policy. More than 500 management representatives are expected to attend.

### Computers

Technical papers by 28 of the foremost computer authorities will be presented at the 1956 Eastern Joint Computer Conference and the exhibition which will be held December 10–12 at the Hotel New Yorker and adjoining Manhattan Center, New York, N. Y. Leading manufacturers of computers and associated products will exhibit. Registration fee at the conference is $5 for members of the three sponsoring societies: Institute of Radio Engineers, American Institute of Electrical Engineers, Association for Computing Machinery; $8 for nonmembers. For advance registration ($1 less in each class) write to 1956 Eastern Joint Computer Conference, Box 1599, Grand Central Station, New York 17, N. Y.

### Electric-Arc-Process Celebration

Fifty years of electric-furnace steelmaking will be celebrated at the 14th annual Electric Furnace Steel Conference, sponsored by the Electric Furnace Steel Committee of the American Institute of Mining, Metallurgical, and Petroleum Engineers, to be held December 5–7, in the Morrison Hotel, Chicago, Ill.

A number of important technical papers have been scheduled, and a program of tours on December 5 will include plant trips.

# ASME News

## With Notes on Society Activities and Events

E. S. Newman, *News Editor*

**The ASME group who went on the scenic, circle air trip over Colorado highlighting such places of interest as the new Air Force Academy, Colorado Springs and beautiful, colorful mountain country around Denver. The trip was one of the outstanding events of the 1956 ASME Fall Meeting in Denver, Colo., September 10–12. Also viewed from the air was Pikes Peak. At Pueblo the plane circled the giant Colorado Fuel & Iron steel mill. From Pueblo, the trip continued to Canon City and the Royal Gorge of the Arkansas River, and the world's highest suspension bridge. Then flying northward to Rocky Mountain National Park along the Continental Divide, the group saw magnificent scenery—snow-capped peaks and "belts of gold" formed by the aspen trees in blossom. On the return trip towering peaks and the famous resort town of Estes Park, the Big Thompson Canyon, and the city of Boulder were all clearly visible.**

## Rocky Mountain Section Host to 1956 ASME Fall Meeting in Denver

### *More than 330 engineers attend technical sessions on solar energy, technical education, automation, and other recent, notable technical developments*

"America is an entity containing within itself all the ingredients necessary for its growth and success—or for its decline and failure," ASME President J. W. Barker pointed out at the President's Luncheon, in his talk, "Competition Begins at Home."

This function highlighted the opening day of the 1956 Fall Meeting of The American Society of Mechanical Engineers held September 10–12, at the Cosmopolitan Hotel in Denver, Colo., with the Rocky Mountain Section of the Society acting as host.

"This is a fact we cannot repeat too often," he added, "for it may help to clear up some of the confusion about our competition with the Soviet Union in the training of scientists and engineers. The figures which indicate that Russia is outstripping the United States in the training of scientists and engineers are valid and they are significant."

"I should be the last person in the world to ridicule them," Dr. Barker declared, "but I think it is more important for us to look at our engineer shortage in terms of our own requirements and not in terms of a frantic contest to make our statistics look better than those of the communists."

"Examined on that basis," Dr. Barker said, "the engineer shortage is extremely serious and may get a lot worse before it gets any better."

He cited figures just released by the Special Surveys Commission of Engineers Joint Council with the staff assistance of the Engineering Manpower Commission, groups set up to work on common problems of the major engineering societies. The figures, based on questionnaires received from 414 industrial and government organizations employing about 140,000 engineering graduates, showed that these organizations expected to increase the number of their engineer employees by 10.4 per cent before the end of 1956 and that their actual estimated requirements would call for an increase of 14.2 per cent if the men were available. (See Mechanical Engineering, October, 1956, pp. 990–991.)

Figures for some specific categories on the increase of engineers expected and wanted by Jan. 1, 1957, were as follows: transportation-equipment industry, 22 per cent more expected, 35 per cent more wanted; makers of professional and scientific instruments, 15 per cent more expected, 26 per cent more wanted; federal, state, and local government agencies, 5 per cent expected, 11 per cent wanted.

Dr. Barker said that the problem tends to intensify itself because schools are unable to compete with industry to get the teachers to train more engineers, and because modern technology is increasing the demand by requiring a greater proportion of engineers to other workers in the labor force.

"Our technology is threatening to strangle itself in its own complexity, simply because engineers and scientists are themselves creating the need for more engineers and scientists, in geometrical progression. Herman Wouk, in 'The Caine Mutiny,' described the Navy as a master plan devised by geniuses for execution by idiots. It may be that some day someone will describe our technology as a master plan designed by a few geniuses for execution by a great many geniuses," Dr. Barker said.

Among the corrective measures suggested by Dr. Barker were renewed personal interest by engineers in their local school systems and an increase in the amount of personal and corporate gifts to institutions of higher learning.

Clifford H. Shumaker, Vice-President, ASME Region VIII acted as toastmaster and George V. Kelly, executive assistant to the Mayor of the City of Denver, welcomed the guests to the city and presented the "Denver Dollar" to Dr. Barker.

## President Barker Confers With Governor Johnson

In a statement issued after a meeting with Colorado Governor Ed C. Johnson, September 10, at which the problem of the current critical shortage of high-school mathematics and science teachers was discussed, Dr. Barker urged that retired engineers and scientists be recruited to teach on a part-time basis.

Present at the meeting with Dr. Barker and Governor Johnson was Robert F. Blanks, who represented the Colorado Engineering Council, composed of representatives of major engineering societies. Mr. Blanks is vice-president of Great Western Aggregates, Inc., of Denver.

Many retired men and women, Dr. Barker added, pensioned off by their companies at age 65, would make excellent teachers. Often, under today's regulations, they are excluded from the teaching profession by regulations which require a minimum number of hours of training in educational techniques, he added.

"Right now, these regulations often act, not to raise our educational standards, but to lower them," Dr. Barker said. "At the same time that America needs more engineers and scientists we find that our future supply is being choked off right at the source, at the high-school level."

Educators throughout the country have expressed concern over the fact that a high proportion of our high-school students receive such inadequate instruction in science and mathematics that they cannot qualify for admission to college.

Dr. Barker urged greater public interest in the personnel requirements of local school systems and suggested that it is the duty of parents, business men, and others to work with school boards to amend those requirements, at least temporarily, if they are found to be "unrealistic or operating to exclude qualified people from our school systems."

Older persons who taught only on a part-time basis would not burden school pension systems nor interfere with the promotion or advancement of younger teachers. They would, however, help to fill present needs for teachers, Dr. Barker said.

Dr. Barker also said he agreed with the position taken at the Governors' Conference in Atlantic City, N. J., by Governor Johnson, advocating the use of teacher's aides to relieve teachers of routine administrative details.

## Technical Program

***Solar Energy.*** Furnaces heated by the rays of the sun, often considered a future source of unlimited energy for industry, are already serving as valuable tools for scientists and engineers.

An analysis of the value of solar furnaces was contained in a paper presented by Guy Beneviste and Nevin K. Hiester of Stanford Research Institute, Menlo Park, Calif.

Because solar furnaces generate temperatures of more than 6000 F in an atmosphere free of burning gases, electrode fragments, or other impurities, researchers can heat samples without exposing them to unwanted contamination.

Use of solar furnaces in developing and producing cermets and other special alloys is of particular significance because of the current interest in such high-temperature materials for use in jet and rocket engines. Solar installations have also been used to conduct high-temperature research programs in oxidizing atmospheres, in air, and in controlled atmospheres with special quartz containers. High-temperature refractories have been purified in the furnaces.

According to the authors, the largest solar furnace installed to date is a unit 200 ft in diam, built by The Centre National de la Recherche Scientifique in France. Another of the same size is planned for installation in New Mexico by the U. S. Air Force.

The theory of solar furnaces has been known since ancient times but only recently explored in a systematic way. Modern research installations use either lenses or a series of mirrors to attain their high temperatures.

To use the solar furnace effectively, attention must be given to many details such as physical mountings, sun-tracking mechanisms, target holders, control mechanisms, and so on. Even with these problems, said the speakers, it will prove an important tool in the research and development of new high-temperature metals for industry.

Although the solar furnace is coming into prominence only now, the principle is not new, the authors pointed out. According to an ancient account, Archimedes defended the city of Syracuse by setting fire to the invading navy of Marcellus, using "a burning glass composed of small square mirrors moving every way upon hinges, which when placed in the sun's rays, directed them upon the Roman fleet, so as to reduce it to ashes at the distance of a bow shot."

**The shortage of science and mathematics teachers is discussed at the Governor's office in Denver. At the meeting, September 11, ASME President Barker, *left,* presents his proposal to help relieve the shortage by using retired engineers and scientists to teach high-school students, to Governor Ed Johnson, *center.* R. F. Blanks, *right,* representing the Colorado Engineering Council, looks on.**

**Chances are the discussion dealt with solar energy and its application when, *left to right,* A. S. Leonard, R. Lepetich, J. I. Yellott, and R. C. Hadley paused to chat**

Although it is possible, in theory, to obtain temperatures up to 4500 C, various losses cut the practical attained temperature to 3500 C, or about 6300 F, the speakers said. This corresponds to an equilibrium heat flux absorbed by the target of about 1000 watts per sq centimeter, if conduction and convection losses, about one-third of all losses, are disregarded.

The basic principle behind the solar furnace is that the sun's intensity yields from 0.8 to 1.1 kw of energy per sq meter at the earth's surface. These figures, rough approximations applying to many parts of the United States, will vary according to the season, altitude, latitude, clearness of the atmosphere, and other factors. Gathering this energy and concentrating it at a focal point is the job of the solar furnace. Because lenses are costly, most solar furnaces operate with parabolic mirrors.

In addition, a paper by J. I. Yellott, an authority in the field, dealt with using the energy of the sun to power radio transmitters in next year's earth satellite, development of solar energy in the Soviet Union, use of solar energy to power steam, hot air, and a modified "turbojet" engine. Mr. Yellott had statistics that indicate that solar energy will become increasingly important in this century as reserves of oil, coal, and nuclear fuels run low. He underscored his statistics by stating that 95 per cent of the world's population lives within latitudes in which solar energy is a potential source of power.

***Power.*** Centralized control for steam-electric generating stations offers the advantages of greater power production per employee needed, and improved performance during start-up and emergencies. On the other hand, variations in operating efficiency of extremely large units justify more elaborate supervisory control.

Potential savings through more economical loading of today's units are sizable, and will be far greater in the future as generating-unit sizes increase and transmission systems become more complex. Thus instrumentation for future generating stations should be split into three groups according to P. S. Dickey, president of Bailey Meter Company, Cleveland, Ohio, in his paper. He suggested the groups be divided as follows:

1 Instrumentation needed to guide the operators. This will be a simplified version of the instruments used in today's control centers. It will be designed for maximum reliability, suitable for actuation of automatic controls, and will include the necessary indicating and recording devices to guide the operator during normal, start-up, and emergency operation.

2 Data-gathering and analog-type processing equipment for precise performance determination. This instrumentation will be of the highest possible precision, and applied so it can be easily removed from service for checking.

3 Instruments transmitting to scanning devices designed to accomplish any desired objective from simple fault analysis to complete detailed performance testing of major units and/or auxiliaries.

This splitting of instrumentation offers such advantages, according to the author, as (1) simplifying the control center, (2) permitting the gathering and processing of precise performance data outside the control center, and (3) facilitating the direct and continuous sending of incremental cost data to the load dispatchers for economical loading of the system.

This arrangement will also eliminate the need for a large results department. The data-processing equipment will prepare permanent continuous records of unit performance, and complete test data can be taken and interpreted continuously during early stages of operation.

***Automatic Office.*** When office automation catches up with factory automation, you can burn the blueprints and tear up the paper work, because electronic machines will be making the decisions, stated H. Ford Dickie, a General Electric engineer. An automatic system in which the typing of the customer's order would be the first and last manual operation was seen as a key to reduced operating costs.

"The 'paper curtain' separating manufacturing, finance, marketing and engineering may be torn down," Mr. Dickie said, as plants become more automatic. This destruction of barriers between departments may well bring new benefits in the form of "functional integration."

Starting at the time a customer's order is received, Mr. Dickie described an electronic system that would automatically transmit information to the manufacturing plant, the district office, the warehouse, and the customer. At the factory other machines would maintain inventory information and schedule various manufacturing steps through a complicated system that would take into account dozens of variables and instantaneously adjust itself whenever an unexpected event, such as a breakdown, occurred on the production line.

Machines to perform these complex functions are now available or will be on the market within a year.

At the same time that machines become more complex, Mr. Dickie said, systems and procedures should be simplified. He quoted a statement by a fellow-engineer, Dr. Zay Jeffries: "Our progress depends to a considerable extent on seeing to it that the simplification processes move forward in approximate balance with the complicating processes (so that) individuals do not become casualties of their own complexities."

In time, progress in the mechanization of manufacturing control will fully match automation advancements in the shop. Production control systems, Mr. Dickie pointed out, have been stagnant for 20 years. But the advent of operations research techniques, the greater interest of industrial engineers in production management and the increasing availability and understanding of electronic computers promise a brighter future for office automation.

"Offices process data," Mr. Dickie said, "the way a factory processes steel and copper. Data are the raw material for the production control office. On this raw material various

**N. K. Hiester, co-author of "The Solar Furnace: New Tool for High-Temperature Work," discusses the paper at a technical session**

**Delbert Faust, *left,* and M. B. Trillhaase, *center,* chairman and vice-chairman, respectively, of a Production Engineering Session, discuss a technical paper by H. Ford Dickie, *right***

operations are performed—sorting, filing, multiplying, rearranging, summarizing, comparing. The data are transformed into a finished product—informational reports.

"Just as a finished product of a factory is valuable only when it is salable, similarly the finished product of the office—reports, orders, etc.—are valuable only when they give a firm foundation for operating decisions."

Mr. Dickie contrasted today's conventional systems, under which an office staff handles great masses of paper work and goes through a process of trial and error to arrive at an efficient work load on production machines, to a new scheduling computer. This desk-size machine which stores thousands of pieces of information in its electronic "memory" enables a scheduler to determine the load on his production line simply by setting a dial for the quantity of products desired. The machine automatically extends, summarizes, and instantaneously compares this potential load with the available production capacity.

Such systems cut manufacturing cost by reducing idle machine time.

General Electric is applying the principle of integrated data processing in several automation projects, putting production data in a form the machines can "digest" the first time it is used.

One system now in use involves transmitting customers' orders by telegraph directly from the sales offices all over the country to the plants producing the equipment. With this method, an exact duplicate of the customer's order and a punched tape are received at the plant. The tape provides selected data for punched cards which are then used in production control as well as in other functions, such as finance and marketing.

Mr. Dickie also outlined other aspects of a completely automated plant including a single center combining engineering and factory operational planning, production scheduling, and marketing-data planning. No more blueprints would be sent into the shop. Instead, magnetic tapes would guide the machines in time, quantity, and dimensions.

Incentive systems may be based on good maintenance and the number of hours the automated equipment is in operation.

There will be greatly increased emphasis on reliable marketing forecasts.

Monday morning test runs will be made on the automated system to see whether all "automata" are in condition for the full range of tasks for the week ahead.

Other technical papers presented discussed developments in gas-turbine power, machine design, power, education, hydraulics, production engineering, and process industries.

Digests of available papers will appear in the "ASME Technical Digest" Section in forthcoming issues of MECHANICAL ENGINEERING.

## Availability List for 1956 ASME Fall Meeting Papers

THE papers in these lists are available in separate copy form until July 1, 1957. Please order only by paper numbers; otherwise the order will be returned. Copies of these papers (25 cents to members; 50 cents to nonmembers) may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

***Paper No.*** ***Title and Author***

### Gas Turbine Power

56—F-20 5000-kw Dual-Fuel Gas Turbine for Industrial Power, by R. J. BROWN and A. N. SMITH

56—F-21 An Industrial Plant Installation of a Gas Turbine to Generate Power and Process Steam, by H. L. DWYER and C. A. PAYNE

### Heat Transfer

56—F-6 Turbulent Free-Convection, Heat-Transfer Rates in a Horizontal Pipe, by J. P. FRASER and D. J. OAKLEY

56—F-9 Mollier Diagrams for Water Near Bubble Point, by ANDRE VAN HAUTE and B. H. SAGE

56—F-11 Determination of Thermal Conductivities of Metals by Measuring Transient Temperatures in Semi-Infinite Solids, by S. T. HSU

### Hydraulics

56—F-8 Development of Hydraulic Operation for Gates and Valves, by W. H. KOHLER

56—F-10 Cavitation Characteristics of Gate Valves and Globe Valves Used as Flow Regulators Under Heads up to About 125 ft, by J. W. BALL

### Machine Design

56—F-1 Curved Beams With Eccentric Boundaries, by J. P. VIDOSIC, F. J. BOGARDUS, and J. C. DURDEN

56—F-3 Graphical Shoe-Brake Analysis, by G. A. G. FAZEKAS

56—F-4 Kinematic Analysis and Synthesis Using Collineation-Axis Equations, by W. J. CARTER

56—F-5 Tables of Functions for Short Cylindrical Shells, by R. B. MCCALLEY, JR., and R. G. KELLY

56—F-18 Calculating the Size of Flywheel Required for a Synchronous Motor-Driven Reciprocating Compressor, by M. N. HALBERG

### Management

56—F-12 Human Factors in Engineering Management, by H. M. MILLER, JR.

56—F-17 Engineering Management in Reclamation, by L. N. MCCLELLAN

### Power

56—F-7 The Solar Furnace—New Tool for High-Temperature Work, by GUY BENVENISTE and N. K. HIESTER

56—F-13 Boiler Cleaning—Methods and Controls, by L. B. SCHUBLER

56—F-14 Instruments and Control—Key to Economical Performance of Steam-Power Plants, by P. S. DICKEY

56—F-15 Power from Solar Energy—Some Fundamental Factors, by J. I. YELLOTT

56—F-16 Estimating Partial-Load Performance of Large Reheat Turbine-Generator Units, by S. D. FULTON and D. W. R. MORGAN, JR.

56—F-22 Utilization of Lignite, by E. C. MILLER and C. F. HAWLEY

### Process Industries

56—F-19 A Preliminary Analysis of a Turning Jet, by A. S. LENARD

### Production Engineering

56—F-2 Measurement and Mechanization of Production-Control Scheduling, by H. F. DICKIE

Shown at head table, Welcoming Luncheon, held during the 11th Annual Petroleum Mechanical Engineering Conference, September 2, are *left* to *right:* J. M. Stevenson, Chairman of Technical Events; Lowell Wilhoit, Chairman of Registration; John Lee, Chairman of Hotels; William B. Gregory, Chairman of Finance; H. H. Meridith, Jr., Secretary of the Petroleum Division Executive Committee; M. A. Scheil, Chairman of the Petroleum Division Executive Committee; Joseph W. Barker, President, ASME; C. H. Shumaker, Vice-President, Region VIII ASME; I. H. Comroes, Chairman of the North Texas Section of the ASME; J. W. Lacy, Vice-Chairman and Secretary of the Dallas Arrangements Committee; J. M. Clark, Divisions Manager; J. S. Rearick, Vice-Chairman of the Petroleum Division Executive Committee; Alex Quayle, Vice-Chairman of Reception Committee; Ben C. Heald, Chairman of Entertainment Committee; E. R. Holloway, Chairman of Plant Trips; and James A. LeVelle, Vice-Chairman, Publicity Committee

# More Than 700 Attend Successful ASME Petroleum Mechanical-Engineering Conference in Dallas

The eleventh annual Petroleum Mechanical-Engineering Conference, sponsored by the Petroleum Division of The American Society of Mechanical Engineers with the co-operation of the North Texas Section, was held September 23–26 at the Statler-Hilton Hotel, Dallas, Texas.

More than 700 engineers from the United States, Canada, and Venezuela, representing every phase of the industry, were in attendance and some actively participated in the outstanding program covering the mechanical problems of the petroleum industry.

## President's Luncheon

ASME President Joseph W. Barker delivered the address at the Welcoming Luncheon on "Industry, Education, and Professional Societies" after greetings from the Hon. R. L. Thornton, Mayor of Dallas, and a response by Clifford H. Shumaker, Vice-President, ASME Region VIII.

President Barker called attention to the fact that "Our American way of life is founded upon the art of applying the great sources of power in nature for the use and convenience of man." Each new application of scientific discovery calls for more engineers.

"As late as 1900 there was one engineer-scientist for every 250 employees in American industry. By 1950 this ratio had increased to one for 60 employees and in 1953 the General Electric Company reported one engineer-scientist for every 15 employees. In the aircraft industry in 1954, the ratio was one for every eight."

Unless the demand materially slackens, he pointed out, a current shortage of 24,000 engineers will become 43,000 by 1964. A further complication is the fact that the pressure for more training will prevent any great improvement in the quality of engineering education for some years to come.

## Social Events and Banquet

The meeting was launched Sunday night, September 23, at a "Get Acquainted" reception at the hotel. This reception was presided over by Frederick F. Murray, president of the Oil Well Supply Division of US Steel Corporation. More than 500 registrants and their wives attended the Monday night cocktail party which was held at the Dallas Athletic Club.

The banquet given Tuesday night was highlighted by awards presented by M. A. Scheil, chairman, Petroleum Division, ASME, and an address by L. T. Potter, executive vice-president of Lone Star Gas Company. Mr. Potter said, "The engineer in the modern industrial world must be more than a pure technician to be truly successful. He must make his contribution to the building of the human spirit. The human spirit may blossom more often, if not more sublimely, in the work-a-day world than in any other way." He explained that in the program the title of his talk read "Engineering—A Life." The theme, however, was "engineering a life." E. J. Wacker, Jr., Chairman, Dallas Arrangements Committee, presided.

## Technical Program

The technical program consisted of 35 papers and two panel discussions presented in 20 sessions. Various phases of the industry including economics, job evaluation and industrial psychology, and automation, as well as maintenance, mechanical design, construction, operation code and development problems were considered.

Digests of available papers will be published in the "ASME Technical Digest" section in forthcoming issues of Mechanical Engineering.

## Inspection Trips

Two inspection trips were scheduled and sessions were suspended on Tuesday afternoon to encourage participation. One trip visited the Magnolia Pipe Line Company's Keller Station. This is a 2500-hp motor-driven centrifugal pump station, which is remotely controlled from an operating console located some 100 yards from the pump station.

Those who went on the other trip visited the Emsco Derrick and Equipment Company's D & B Garland plant and the Oil Well Supply Division of the US Steel Corporation.

## Women's Program

In addition to the President's Luncheon, the banquet, and the cocktail party at the Dallas Athletic Club, the special program arranged for the women included various receptions, coffee hours, and a luncheon and style show at the County Club.

## Availability List of Papers for 1956 ASME Petroleum Mechanical Engineering Conference

THE papers in this list are available in separate copy form until July 1, 1957. Please order only by paper numbers; otherwise the order will be returned. Copies of these papers (25 cents to members; 50 cents to nonmembers) may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

| Paper No. | Title and Author |
|---|---|
| 56—PET-1 | Mechanical-Design Problems Connected With Ammonia Synthesis, by C. E. FREESE |
| 56—PET-2 | The Maintenance Challenge in a Petrochemicals Plant, by P. S. SKAFF |
| 56—PET-3 | Psychological Tests in an Engineering Department, by J. M. PARISH |
| 56—PET-4 | Models as a Design Tool, by B. L. PATON |
| 56—PET-5 | Maintenance-Organization Factors in the Modern Refinery, by C. H. TROTTER |
| 56—PET-6 | Problems Encountered in the Manufacture and Rating of Air-Heat Exchangers, by J. I. CARTER |
| 56—PET-7 | Practical Economics for Refinery Mechanical Engineers, by T. S. FENNEMA |
| 56—PET-8 | Selection of Materials for Construction of Catalytic Reforming Units, by J. J. HUR, J. K. DEICHLER, and G. R. WORRELL |
| 56—PET-9 | Hydraulic Drives Using Rich Oil-Power Units, by B. J. THOMPSON |
| 56—PET-10 | A Program for Controlling Construction Costs, by J. E. Ross |
| 56—PET-11 | Radiographic Inspection of Lead Linings During Fabrication, by W. SKIBA |
| 56—PET-12 | Problems Encountered in the Selection and Use of Air-Cooled, Heat-Transfer Equipment, by T. H. KING and D. D. BROWN, JR. |
| 56—PET-13 | Operating Considerations in the Application of Gas-Turbine-Driven Centrifugal Pipeline Compressors, by A. L. VAUGHAN |
| 56—PET-14 | Remote Control and Operation of Booster Stations on the Platte Pipeline System, by F. D. MARTS |
| 56—PET-15 | Maintenance Welding High-Test Line Pipe, by A. M. HILL and F. W. ZILM |
| 56—PET-16 | Apparatus for Sampling Particulate Matter in High-Pressure Gas Streams, by R. L. SOLNICK |
| 56—PET-17 | Cold-Weather Pipe Lining, by J. E. LYLE |
| 56—PET-18 | Job Evaluation—A System of Salary Determination, by A. DE LEON |
| 56—PET-19 | Performance of 6061-T6 Aluminum Flanged-Pipe Assemblies Under Hydrostatic Pressure, by H. H. GEORGE, E. C. RODABAUGH, and M. HOLT |
| 56—PET-20 | Experience With Positive Displacement Meters in Oil-Pipe Service, by D. C. MCKINLEY |
| 56—PET-21 | Materials Aspect of Some High-Temperature, Refinery-Piping Applications, by E. A. STICHA |
| 56—PET-22 | Remote-Controlled, Engine-Driven, Centrifugal, Gas-Compressor Station, by R. LOCHIANO |
| 56—PET-23 | Strength Characteristics of Rock Samples Under Hydrostatic Pressure, by R. O. BRED-THAUER |
| 56—PET-24 | Offshore Mobile Units—Present and Future, by R. J. Howe and B. G. COLLIPP |
| 56—PET-25 | Application of Diesel-Electric Traction Power to Oil-Well Drilling, by B. H. HEFNER |
| 56—PET-26 | Electrification of Oil-Well Drilling Rigs—Using Transportation-Type Equipment, by F. A. COMPTON, JR., and C. D. NEITHAMER |
| 56—PET-27 | On Porosity and Rock Strength, by A. D. TOPPING |
| 56—PET-28 | Semi-Automatic, Gas-Engine-Driven, Centrifugal, Gas-Compressor Station, by G. B. MCINTOSH, JR. |
| 56—PET-29 | Practical Aspects of Using Diesel-Electric Railway Equipment on Drilling Rigs, by H. D. REDDING |
| 56—PET-30 | Prevention of Destructive Engine Failure by Spectrographic Analysis of Crankcase Oil, by R. E. LINNARD, C. B. THRELKELD, and R. T. BLADES |
| 56—PET-31 | Pulsation Absorbers—Their Design and Application, by H. M. WYATT, JR. |
| 56—PET-33 | Lease Automatic Custody Transfer, by S. H. POPE |
| 56—PET-34 | Design of Manifold Fittings for Special Temperature and Pressure Conditions, by W. R. WOLLERING and A. J. VAZQUEZ |
| 56—PET-35 | Aluminizing Aspects of Fabricated Pipe and Piping Components, by E. M. PELOUBET |

## ASME Coming Events

**Nov. 25–30**
ASME Annual Meeting, Hotel Statler; National Power Show, Coliseum, New York, N. Y.
*(Final date for submitting paper was July 1, 1956)*

**March 10–16, 1957**
EJC Nuclear Engineering and Science Congress, Convention Hall, Philadelphia, Pa.
*(Final date for submitting paper was Nov. 1, 1956)*

**March 18–21, 1957**
ASME Gas Turbine Power Conference, Hotel Sheraton-Cadillac, Detroit, Mich.
*(Final date for submitting papers was Nov. 1, 1956)*

**March 27–28, 1957**
ASME Engineering Management Conference, Hotel William Penn, Pittsburgh, Pa.
*(Final date for submitting papers was Nov. 1, 1956)*

**April 8–10, 1957**
ASME Spring Meeting, Hotel Dinkler-Tutwiler, Birmingham, Ala.
*(Final date for submitting papers—Dec. 1, 1956)*

**April 22–24, 1957**
ASME Instruments and Regulators Conference, Northwestern University, Chicago, Ill.
*(Final date for submitting papers—Dec. 1, 1956)*

**April 25–26, 1957**
ASME Railroad Conference, Hotel Sheraton, Chicago, Ill.
*(Final date for submitting papers—Dec. 1, 1956)*

**April 25–26, 1957**
ASME Management-SAM Conference, Hotel Statler, New York, N. Y.
*(Final date for submitting papers—Dec. 1, 1956)*

**May 16–17, 1957**
ASME Wood Industries Conference, Winston-Salem, N. C.
*(Final date for submitting papers—Jan. 1, 1957)*

**May 19–23, 1957**
ASME Oil and Gas Power Conference, Kentucky Hotel, Louisville, Ky.
*(Final date for submitting papers—Jan. 1, 1957)*

**May 20–23, 1957**
ASME Design Engineering Conference, Coliseum, New York, N. Y.
*(Final date for submitting papers—Jan. 1, 1957)*

**June 9–13, 1957**
ASME Semi-Annual Meeting, Sheraton-Palace Hotel, San Francisco, Calif.
*(Final date for submitting papers—Feb. 1, 1957)*

**June 13–15**
ASME Applied Mechanics Conference, University of California, Berkeley, Calif.
*(Final date for submitting papers—Feb. 1, 1957)*

**August 11–15**
ASME Heat Transfer Conference, Pennsylvania State University, University Park, Pa.
*(Final date for submitting papers—April 1, 1957)*

**Sept. 9–13**
ASME IRD-ISA Conference, Auditorium, Cleveland, Ohio
*(Final date for submitting papers—May 1, 1957)*

**Sept. 22–25**
ASME Petroleum Mechanical Engineering Conference, Hotel Mayo, Tulsa, Okla.
*(Final date for submitting papers—May 1, 1957)*

**Sept. 23–25, 1957**
ASME Fall Meeting, Hotel Statler, Hartford, Conn.
*(Final date for submitting papers—May 1, 1957)*

**Oct. 7–9, 1957**
ASLE-ASME Lubrication Conference, Royal York Hotel, Toronto, Ont., Canada
*(Final date for submitting papers—June 1, 1957)*
*(For Meetings of Other Societies, see page 1070)*

# ASME IRD Activity Boosts ISA Conclave

DURING the week of September 17–21, many members of The American Society of Mechanical Engineers were among the 36,000 who registered at the New York Coliseum in New York, N. Y., to view 450 equipment exhibits and attend 45 technical sessions in the Instrument Society of America's eleventh annual conference and exhibit.

ASME people—especially participating Instrument and Regulator Division members—were not at this huge conclave by accident. Instruments and automatic-control equipment primarily mechanical or electromechanical in character dominated the booths and the sessions abounded with papers describing progress in a wide variety of mechanical systems for continuous process measurement and control. But even beyond this incentive, our Society visitors had a real stake in this meeting: two of the most important and well attended technical sessions at the meeting were planned and run by the ASME. On Monday, September 17, Bruce Hainsworth (Boston Section) chairmanned a group of three Instrument and Regulators Division papers on linear process control and valve dynamics. And on Tuesday, September 18, Bob Lovett (Wilmington Session), substituting for W. E. Vannah (N. Y.), ran a session which included papers on process and on wind-tunnel dynamics.

Harry Karp, associate editor of *Control Engineering*, has this to say of the IRD sessions at the ISA meeting, "To my mind they were one of the most highly successful and high-caliber technical sessions of the week. The most notable paper, from my standpoint, was the offering by Shell Development's Percy Cowley on 'The Application of an Analog Computer to the Measurement of Process Dynamics'" (Paper No. 56—IRD-20).

Other sessions, sponsored directly by ISA, covered instrumentation for: testing, process analysis, production processes, transportation, biology and medicine, nuclear radiation, aeronautics, and physical properties. There were also excellent workshops and clinics in data handling, maintenance, analytical instruments, and special symposiums on "Computers in Process Control," "Human Engineering," and "Management Problems in Automation." Copies of the entire proceedings are available in two volumes ($8 each to nonmembers) from the ISA's national headquarters, 313 Sixth Avenue, Pittsburgh 22, Pa.

ASME members attending the product show say that the booth exhibits were superb—ranging from scores of displays of the familiar industrial measuring instruments (many completely new in design and operational characteristics through information-handling equipment,

**Over-all view shows some of the equipment displays at the ISA eleventh annual Instruments Automation Exhibit at the Coliseum, New York, N. Y., September 17–21**

**The most spectacular and well-attended exhibit at the ISA show was the first public display of Naval Research Lab's full-scale model of the earth satellite. National Bureau of Standards Chief, A. V. Astin, sitting, and ISA's 1955–1956 President Robert T. Sheen standing by the "moon."**

**Clinics and workshops were an important part of the Instrument Society of America conclave. This one had to do with the principle of operation and applications for analytical instruments. The unit on the bench is a new gas chromatography analyzer.**

data loggers, telemetering systems, computers, and the like) on to a variety of actuators (control valves, servos, some motors, and so on). Pooling the comments of a few of these visitors, the equipment trends at the show were summed up as—

* many more ruggedized in-stream type instrument analyzers on display this year
* there was great emphasis on the "systems approach" in the booths
* several new fast-response electrohydraulic and one new all-electric valve actuator indicated the interest in this area
* at least four companies have brought out new data-logging equipment in 1956

Next year's ISA conclave will take place in September in Cleveland, Ohio, ASME IRD people are already well into plans to participate as strongly—and as well—in this forthcoming affair.

### Navy's Full-Scale Earth Satellite Shown

The U. S. Navy exhibited a full-scale model of an earth satellite in which man hopes, a year from now, to make his first tentative probings of outer space. The scientists, during the technical session, predicted that observations of an orbiting satellite would enable man to know the size and some aspects of the shape of the earth to within an accuracy of 30 ft. This would reduce by a few hundred feet the uncertainty that science feels in respect to the size of the earth.

The exhibit was a shiny, magnesium alloy globe, about 20 in. in diameter. The model had four radio aerials, each about 3 ft in length, and a few tiny windows through which measurements will be made if the experiments are a success.

A Naval Research Laboratory spokesman said that the space vehicle would weigh about 21 lbs when fully loaded. Half the weight will consist of a radio transmitter and a battery of instruments to report details of what space is like a few hundred miles above the surface of the earth.

The Defense Department released some information on these instruments, designed and built by Project Vanguard scientists at the Naval Research Laboratory. A plastic cut-away model of the satellite's interior showed: (*a*) a ten-milliwatt "minitrack" transmitter that will be used to track the vehicle from ground stations; (*b*) tiny pressure, erosion, and temperature gages that will measure space conditions; (*c*) a meteorite-collision microphone that will detect collisions between the satellite and tiny solid particles; and (*d*) "Lyman-Alpha" equipment for measuring the ionization produced by great solar flares on the face of the sun.

## Availability List of Papers for 1956 Instrument and Regulators Conference

The papers in these lists are available in separate copy form until July 1, 1957. Please order only by paper numbers; otherwise the order will be returned. Copies of these papers (25 cents to members; 50 cents to nonmembers) may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

| *Paper No.* | *Title and Author* |
|---|---|
| 56—IRD-19 | The Effect of a Logarithmic Element in an Otherwise Linear Process-Control System, by G. L. D'Ombrain and A. Rashwan |
| 56—IRD-20 | The Application of an Analog Computer to the Measurement of Process Dynamics, by P. E. A. Cowley |
| 56—IRD-21 | Criteria for Validity of Lumped-Parameter Representation of Ducting Air-Flow Characteristics, by G. J. Fiedler and T. R. Stalzer |
| 56—IRD-22 | Application Limits and Accuracies of Control-Valve Flow Coefficient, Cv., by D. J. L. Lin and A. J. Hanssen |
| 56—IRD-23 | An Analytical Study of Linearized Industrial Process Controllers, by D. D. Nye, Jr., and R. Y. Paradise |

# Nominations Open: 1958 ASME Officers

## *Regional Nominating Subcommittee in each Region to be organized*

The 1957 National Nominating Committee of The American Society of Mechanical Engineers, charged with the responsibility of locating eminent leaders for the offices of the Society to be elected by the members for 1958, urge action on the part of the membership. They wish to stress the importance of giving early thought to the matter of searching out qualified individuals to serve as officers of the Society.

In an effort to accomplish this, each Section will be requested to appoint a member to assist the Regional Representative on the National Nominating Committee. These Section representatives will be charged with the responsibility of seeking from their Section's membership, qualified candidates. In this capacity, they will keep attention focused upon this vital and important matter.

Names and addresses of the Representatives and the first and second alternates of the 1957 National Nominating Committee were published on pages 773 and 774 of the August, 1956, issue of Mechanical Engineering.

It is your obligation, privilege, and responsibility as well as that of every other member of the Society to assist the National Committee in obtaining the best men available. You can do your part by acting as a sponsor for those members who have the acknowledged qualities of outstanding ability and leadership in their profession.

### Offices to Be Filled for 1958

| | |
|---|---|
| President | To serve 1 year |
| Vice-President—Region I | To serve 2 years |
| Vice-President—Region III | To serve 2 years |
| Vice-President—Region V | To serve 2 years |
| Vice-President—Region VII | To serve 2 years |
| Director (Technological) (1) | To serve 4 years |
| Director (Codes and Standards) (1) | To serve 4 years |
| Director (Administrative) (1) | To serve 4 years |

In the past there have been apathy and casualness associated with this responsibility, resulting in either no candidates, or candidates picked at random as a last-ditch measure. The Committee believes that the Sections and the Technology, Codes and Standards, and Administrative groups have an abundance of qualified individuals who are ready and able to serve the Society as President, Vice-President, or Director. The Boards, Committees, and Professional Divisions make their recommendations through nominating conferences provided for in the Constitution, By-Laws, and Rules of the Society. These conferences will be called by responsible Board Chairmen in a letter to the chairmen of all committees under their respective jurisdiction.

You may, therefore, make your nomination through your Section's representative, or directly through Raymond H. Stockard, Secretary of the 1957 National Nominating Committee, University of Rhode Island, Kingston, R. I. Your nomination must be on forms which can be obtained from members of the Nominating Committee as well as the New York office.

## ASME Elects New Officers by Letter Ballot

As reported by the tellers of election, 1957 officers, L. C. Morrow, A. R. Mumford, and R. W. Flynn, letter ballots received from members of The American Society of Mechanical Engineers were counted on Sept. 25, 1956. The total number of ballots cast was 12,353; of these 169 were thrown out as defective.

| | *Votes for* | *Votes against* |
|---|---|---|
| *For President* | | |
| William Francis Ryan | 12,160 | 24 |
| *For Regional Vice-Presidents —serve two years* | | |
| William Henry Byrne | 12,157 | 27 |
| James Hagood Sams | 12,157 | 27 |
| Rolland S. Stover | 12,163 | 21 |
| Clifford H. Shumaker | 12,158 | 26 |
| *For Directors —serve four years* | | |
| Eugene William Jacobson | 12,160 | 24 |
| V. Weaver Smith | 12,167 | 17 |

The new officers will be introduced and installed in office during the 1956 Annual Meeting of the Society to be held at the Statler and McAlpin Hotels, New York, N. Y., November 25 through 30, inclusive.

Biographical sketches of the newly elected officers were published in the August, 1956, issue of MECHANICAL ENGINEERING, pages 785 to 788. ASME Annual, AC-10, published early each year contains complete lists of officers.

# Junior Forum

## Conducted for the National Junior Committee

by R. A. Cederberg,[1] Assoc. Mem. ASME

## Are Engineers Underpaid?

### *Report of the Junior Session at 1956 ASME Fall Meeting, Denver, Colo.*

By Oscar E. Froid[2]

THE topic "Are Engineers Underpaid?" proved to be a most interesting and challenging one of general interest for the Junior Session conducted at the Fall Meeting of The American Society of Mechanical Engineers in Denver, Colo., Sept. 10–12, 1956.

A panel of three speakers, each well established in the engineering profession, presented their views on this topic. The room originally assigned to hold this particular session proved too small and the meeting had to be moved to one three times as large to adequately hold the interested audience.

Ralph Withrow, an engineer with vast practical experience and an authority on power-plant design injected the thought that, "Our profession should do everything in its power to assist industry in keeping the price of our products down or we will price our product right out of the world market. As the engineers are the 'Intelligentsia' we should be well aware of the direction and rate of climb that prices have been taking and the economic pitfall that lies ahead if they are not checked. This, although mass production has achieved astounding results, can only result through engineer design and planning."

J. A. McCormack, a graduate engineer, 20 years out of college, and a Professional since 1949, declared that force is no way to promote a raise. Well established in the oil and gas processing industry, Mr. McCormack felt that only through an individual's enterprise and increased efficiency was it possible to secure a higher rate of pay.

Don Neithercut, Assoc. Mem. ASME, practicing since 1942, and a Professional since 1955, showed statistically that some engineers are not underpaid, especially those who work on a consulting basis for themselves and can fix their own fee. On the other hand some branches of the engineering-teaching profession are so underpaid that recent engineering graduates find positions in industry paying twice the salary that the educator is receiving. It is only through sideline activities that some of our engineering educators are able to make a living. Mr. Neithercut pointed out that his statistics were substantiated by surveys conducted by the various engineering societies.

The sessions lasted from 8:00 in the evening until well past 10:30 and the participation from the floor was exceptional. If there was a point raised by the panel that did not receive comment from the floor it was a very minor one. One critical reviewer stated that, "If industry is going to start the recent engineering graduate at such a high salary, why, then, must the engineers with five to ten years of experience have to remain at a salary level equal to that of these novices? Why shouldn't they receive a salary that reflected their years of experience, the higher production output resulting from their work, the new products that they have helped to develop, and the increase in the cost of living?

Mr. Withrow brought out the point that engineers do not advertise and therefore the public does not know what the engineer does and how he contributes to the continually rising standard of living that we enjoy. The only ones who know of the engineer's accomplishments are other engineers. It is the public that has to be educated if the engineer is going to attain a full professional status, with a concomitant salary.

At the conclusion of the session, a vote from the floor was requested to determine how many of those present considered the engineer to be underpaid. Results: Unanimous agreement that they are relatively underpaid. Although the meeting ran overtime due to the active participation from the floor, it was not until well into the early hours of the next morning that the small groups which gathered to continue the discussion finally decided to call it a day.

[1] Remington Rand Univac, St. Paul, Minn. Assoc. Mem. ASME.

[2] Oscar E. Froid, Mining Division, Stearns Rogers Manufacturing Co., Denver, Colo., Assoc. Mem. ASME, Vice-Chairman of the Junior Session at Denver.

# ASME Codes and Standards Workshop

## Standardization in the Nuclear Field

***Nuclear Standards Board.*** The organization meeting of the newly formed ASA Nuclear Standards Board was held September 18 in New York, N. Y. Twenty-two organizations were represented at the meeting, which voted to establish six new projects in the field of nuclear energy and to issue invitations to organizations to sponsor sectional committees to handle the work. The Society has received an invitation to sponsor a project on Codes and Standards dealing with Reactor Hazards. The other projects are: General and Administrative Standards, Instruments for Nuclear Reactors, Electrical Requirements for Reactors, Chemical Engineering Standards for the Nuclear Field, and Radiation Protection.

***Glossary of Terms in Nuclear Science and Engineering.*** The glossary, published by the Society, has been submitted to ASA by the National Research Council, for approval as American Standard under the General Acceptance Method. The Nuclear Standards Board discussed this proposed standard, the first standard concerned with the nuclear-engineering field to be submitted to ASA. Approval as American Standard is hoped for shortly. When published as American Standard the glossary will contain revisions made in some of the definitions as a result of the previous extensive distribution of the book.

***Boiler and Pressure Vessel Nuclear Cases.*** Three cases dealing with pressure vessels that are integral parts of a nuclear installation were published in the October, 1956, MECHANICAL ENGINEERING. These are Cases 1224, 1225, and 1226, and are the first in the nuclear field that the Boiler and Pressure Vessel Committee has approved.

## 1956 Addenda to Boiler and Pressure Vessel Code

Work is under way in preparation of the 1956 Addenda and publication is hoped for within a month. Sections which have revisions that will be incorporated in Addenda are: Power Boilers (Sec. I), Material Specifications (Sec. II), Unfired Pressure Vessels (Sec. VIII), and Welding Qualifications (Sec. IX).

# Engineering Societies Personnel Service, Inc. (Agency)

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
8 West 40th St.

Chicago
84 East Randolph St.

Detroit
100 Farnsworth Ave.

San Francisco
57 Post St.

## Men Available[1]

**Works Manager,** BSME; 35, four years' heavy construction, two years' electrical purchasing, three years' light chemical sales, five years light chemical-development management. Will relocate. ME-341.

**Administrative Engineering,** ME; 44; 11 years in management in metal cutting, sheet-metal fabricating, and inorganic-chemical processing. Previous 12 years in production, project, and maintenance engineering. Employees varied from 50 to 6000. Prefers anywhere but deep South. ME-342.

**Research Engineer,** BSME, MS; eight years diversified background in design, development, testing, research, teaching, and administration. Specific areas of experience include textiles, dynamic analysis, and analog computers. Capable report writer. ME-343.

**Administrative Assistant,** MS (ME), MBA in Management, 34; three years superintendent of fabrication and installation of process equipment, one and a half years' efficiency and cost studies, controls, manufacturing costs; four and a half years assistant to superintendent of plate and structural-fabrication plant. Prefers Southwest. ME-344-San Francisco.

**Project or Sales Engineer,** BS (ME), BS Administrative Engineering; 37; seven years' experience on various assignments such as production engineering, methods, cost reduction, plant layout, liaison engineering, construction supervisor, and purchasing. Location immaterial. Me-345.

## Positions Available

**Mechanical Engineer,** 30–50, experience in the design of complex mechanical parts for military electronic equipment. Will direct efforts of draftsmen and modelmakers in the layout and fabrication of parts of his design. Extensive knowledge of materials and finishes. Will supervise tests on completed equipment such as life tests, field tests, and flight tests for operation. $8000–$11,000. Employer will pay fee. Upstate N. Y. W-3878.

**Director of Manufacturing** for multiplant corporation; to 48; graduate ME with ten to 15 years' experience in manufacture of heavy capital goods; multiplant executive experienc; wide knowledge of steel fabricating, welding, and heavy machine-shop practice in durable goods. Will supervise works managers of individual units in several states. Substantial interplant travel is necessary. $20,000–$25,000. Headquarters, New York, N. Y. W-3939.

**Vice-President Engineering,** to 48, preferably MME, to head engineering department of 400; must be registered PE in more than one state. Product engineering in heavy capital goods and heavy ordnance products including tanks, howitzers, etc. Must have 15 to 20 years' engineering experience in heavy durable goods; five to ten years as chief engineer in product engineeering. Must be excellent administrator with ability to plan and direct research, development, and engineering programs. $30,000–$35,000, depending on training, experience, personality, and previous earnings. Headquarters, New York, N. Y. W-3940.

**Industrial Engineer,** 30–35, graduate experience in paper industry, preferably in mill and converting operations. $8000–$10,000. Headquarters, New York, N. Y., with trips to plants. W-3945.

**Production Manager,** mechanical graduate, at least five years' machine-shop, foundry, welding, and metal-fabrication experience to supervise production, production control, tooling, schedules, cost estimating, and equipment layout. $8000–$12,000, plus bonus. Md. W-3992.

**Sales Engineers.** (*a*) Sales engineer, 30–35, mechanical graduate, engineering and sales experience in mining and construction-equipment fields. Considerable traveling. $6000–$7200. (*b*) Assistant sales manager, 40–45, mechanical graduate, engineering, field sales, and staff experience covering construction-mining equipment. $10,000. Eastern Pa. W-3995.

**Production Engineer,** mechanical graduate, planning, estimating, scheduling, follow-up, and co-ordination of production activities for a manufacturer of temperature-control devices. $7000–$8000. Newark, N. J., area. W-3997.

**Materials-Handling Engineer,** 25–40, graduate mechanical or industrial engineer or equivalent, minimum of four years' experience in industrial materials handling, covering all phases from receipt of raw materials through processing to and including packaging. Should be familiar with all methods of materials handling with the possible exception of volume-bulk handling. To $7440. Newark, N. J., area. W-4001.

**Production Superintendent,** 40–50, graduate mechanical or equivalent in practical experience and knowledge, with supplemental training. Knowledge and experience in the supervision of foremen in all phases of manufacturing of special machinery, maintenance parts, subassemblies, and complete assemblies. Must be capable of supervision in layout, set-up methods, sequence of operations, estimating for production and cost data. General knowledge of machine-shop practice on a job-shop basis. $7200–$8400. Prefer applicant in the Ohio area. Ohio. W-4009.

**Mechanical or Electrical Engineer,** graduate, 38–44, broad knowledge of air-conditioning equipment and five to ten years' experience with subcontractor on estimating, design, and construction of complete systems. Competent to analyze drawings and specifications, analyze bids, and participate in closings. Must have reputation for technical competence. $18,000–$20,000. East. W-4020.

**Junior Plant Engineer,** mechanical graduate, either a recent graduate or an engineer with from one to six years' experience. Will assist senior plant engineer in investigations of requirements for the construction of new buildings, additions, and alterations; modernization of equipment and specifications for new equipment. Will plan and make plant and machine layouts, supervise work of outside contractors, follow up on projects being made in machine shop and maintain records of work in process. Salary open. Chicago, Ill. W-4021.

**Mechanical or Industrial Engineers,** at least ten years' diversified experience in metal manufacturing including comprehensive supervision of industrial-engineering functions and methods. (*a*) Specialist to direct extended study of all aspects of budgetary control for tooling including jigs, fixtures, and abrasives. Will cover all paper work, accounting, practices of factory engineering, tool design, tool maintenance, tool-crib control. (*b*) Specialist to review present control practices of $50 million inventory. Should have previous experience in this type of problem; also general knowledge and experience on budgetary control, production control and operations research desirable. To $10,000. Ohio. W-4025.

**Engineers.** (*a*) Senior industrial engineers, about 35, degree in industrial engineering, with five to eight years' experience; will prepare major methods-improvement studies; initiate improvements; make time and motion studies, and prepare standards for industrial-engineering department. $6600–$7800. (*b*) Senior quality engineer, about 35, BS in physics, mathematics, or engineering, five to eight years' experience, to plan and carry out complex phases of major quality-control programs, to develop procedures and facilities and to analyze, evaluate, and interpret results. About $7800. (*c*) Quality engineer, 25–35, BS in physics, mathematics, or engineering, two to five years' experience in quality control. $5400–$6600. Company pays placement fees. South. W-4032.

**Production Assistant to General Manager,** for company fabricating and assembling (as subcontractor) major components of electronic gear with difficult mechanical and electrical characteristics; 35–40; college graduate with engineering (preferably electronic) training. Must have managerial-supervisory experience in one or more areas of manufacturing. Experience in line production and/or production engineering will be given preference. Will assist in manufacturing-production scheduling and control, inspection, and production engineering, with almost immediate responsibility for one or more of these areas. $10,000–$12,000. Southeastern New England. W-4035.

**Textile-Mill Superintendent,** experienced in woolen fabrics and equipment; some finishing and designing experience. Engineering approach desired. $7000, plus bonus. Northern New England. W-4048.

**Production Planning Manager,** engineering graduate, college mathematics through calculus. Minimum of four to six years in production-planning work for an industrial manufacturing company with a wide number and variety of products. Some preference will be given to experience in job-shop press work. Will report to the chief industrial engineer. To $11,000. Pa. W-4050.

**Chief Engineer,** 35–40, graduate, product-design and manufacturing experience in metal stamping, plastic molding, and assembly of novelties and appliances. $12,000–$15,000, plus bonus. Newark, N. J., area. W-4057.

**Designer,** graduate mechanical, considerable experience in heating, air conditioning, and ventilating, to make complete plans and specifications for churches, college, industrial plants, and residences. Salary open. N. C. W-4065.

**Assistant General Manager,** mechanical-engineering training and at least ten years' supervisory estimating, production, and cost experience, covering precision fittings, springs, and instrument accessories. $8000–$12,000. New York, N. Y. W-4086.

**Sales Engineer,** chemical and/or mechanical background desirable, several years' experience selling to the chemical-process industries, to sell small corrosion-resistant pumps. Advancement to field sales manager in charge of representatives. $7500. Headquarters, Newark, N. J. area. W-4090.

**Production Planning and Control Manager,** 34–40, college graduate with engineering and/or business administration preferred, to develop and manage production planning, scheduling, and control for a metal processor-fabricator. Must have production control and/or planning experience at supervisory-managerial level; solid training in and understanding of production-control problems and techniques. Company employs 2000–2500 people. $10,000–$12,000. Southeastern New England. W-4092.

**Industrial Engineer,** graduate mechanical, industrial, or civil, special aptitude for analysis of methods and for space planning; experience in materials handling helpful. Must be able to solve problems in industrial engineering. Some travel. Salary and bonus depending upon experience and qualifications. New York, N. Y. W-4097.

[1] All men listed hold some form of ASME membership.

**Works Engineer,** 35–45, mechanical or electrical graduate, ten years' engineering experience in heavy industry, such as steel. Should have broad background and proved record for administrative resposuibilities over multiplant operations. Will be responsible for engineering of two plants, one a rolling mill and the other a reduction plant engaged in the manufacture of aluminum. Salary open. South. W-4098.

**Teaching Personnel,** rank from assistant professor to department chairman, MS required, PhD desirable, to teach machine design, metallurgy, heat power, aeronautical option, nuclear option, or some combination of these fields. Three mechanical engineers and one nuclear engineer required. Rank and salary commensurate with qualifications. Opportunity for year-round teaching in co-op program. Southwest. W-4100.

**Engineers.** (*a*) Project engineer, graduate mechanical or eight years of broad engineering experience; United States citizen. Should have three or more years' experience as a project engineer; familiarity with environmental tests; working knowledge of both mass production and job-shop manufacturing practices. Will assume full responsibility for a project. $10,000–$15,000. (*b*) Design engineer, senior or junior, graduate mechanical preferred two or more years' experience in the design of small electromechanical devices, to design small precision electromechanical devices refine existing designs for volume production. $7500–$9000. Company pays placement fees. Long Island, N. Y. W-4124.

**Senior Engineer, Plant,** 30–45, BSME or equivalent, six years' experience, background in heavy machine design, preferably mill equipment, oil-field equipment, mine and smelter equipment, etc. Eighty per cent boardwork machine design, major layout, project analysis, supervision of work of subordinates, cost analysis on major rolling-mill engineering jobs. Salary open. State of Wash. W-4125.

**Engineers.** (*a*) Development engineers, two, heat-transfer surfaces, one senior; BS or MS in chemical or mechanical engineering, with sound background in heat transfer, fluid flow, thermodynamics. Will study and evaluate heat-transfer surfaces and corresponding equipment; study competitive heat-transfer equipment; develop radically new types of heat-transfer surfaces, etc. $5000–$8500, depending upon experience. (*b*) Factory engineers, two, heat-transfer surface manufacture, one senior; BS in mechanical or industrial engineering, working knowledge of metallurgy and brazing, soldering, welding techniques. Will study and evaluate methods of manufacturing heat-transfer surfaces of all types, including finned tubes, plate fins, prime surface tubes; devise new methods of coil assembly, etc. $5000–$8500, depending upon experience. Upstate N. Y. W-4130.

**Senior Machine Designer,** six to eight years of machine design, in field of metal-processing machinery. Machine-tool design, packaging, and closure-machine experience considered likely background experience. Will study and evaluate methods of manufacturing heat-transfer surfaces of all types, with a view of actual development of new or improved types of production machines. Ability to think creatively is of utmost importance. $8000–$10,000. Upstate N. Y. W-4131.

**Assistant Plant Manager,** 35–45, mechanical or chemical-engineering graduate, at least five years' managerial and supervisory production experience in process manufacturing in drug or allied fields. $12,000–$15,000. N. J. W-4136.

**Designer, Injection Molds,** at least five years' design-injection experience on plastic molds. Will design molds for plastic-injection machines, some trouble-shooting on molds and some supervision of other designers, for a manufacturer of plastics. To $12,000. Company will pay fee. Chicago, Ill. C-5576.

**Associate Staff Engineer,** mechanical or chemical graduate, 25–40, at least three years in inspection of flammable gas properties or safety work; know production and distribution of L.P. gas. Will be assigned as secretary to technical committees; general correspondence on technical problems; conduct training schools; some speaking engagements and some editorial work; 30 per cent travel, no long trips. $9000–$10,000. Employer will pay fee. Chicago, Ill. C-5605.

**Assistant Engineer,** graduate mechanical or civil, 25–44, five years' experience and interest in an office position; knowledge of concrete helpful. Will assist with analysis and design of various types of concrete pipes and specifications, preparation of standards, equipment design, estimating, production planning, engineering aid to distributors on design, sales, production, and drafting. Specialized training will be given. Five per cent travel. To $9000, depending upon experience. Employer will pay fee. Chicago, Ill. C-5623.

**Mechanical Engineer,** graduate, 30–50, five years' experience in chemical processes, knowledge of piping and ventilating. Will work as a project engineer handling all phases of mechanical work for new plants and the expansion of present plant facilities for a manufacturer of paint. $8500. Employer will pay fee. Chicago, Ill. C-5624.

**Product Designer, Flashlights,** to 40, at least five years in production tooling or production engineering; knowledge of metal forming, drawing, stamping, fabrication, and assembly. Duties will be to design flashlights and related products for mechanized productions. To $8400. Company will pay placement fee. Wis. C-5629.

**Chief Engineer, Pumps,** graduate mechanical or equivalent, 35–55, ten years' experience in responsible design of centrifugal pumps; knowledge of application of pumps. Will report directly to works manager, responsible for department of four or five engineers on design of single and double suction, nonclog type of pumping equipment. Should have some field experience in addition to design. $7500–$10,000. Employer will pay fee. Chicago, Ill. C-5631.

**Staff Industrial Engineer,** to 45, at least five years' experience in plant organization, salary administration, or job evaluation. Duties will include general staff consulting work in above-mentioned phases of industry or management engineering. Considerable travel; no car required. Position is with an industrial consultant. $8400–$9600. Employer will pay fee. Headquarters, Chicago, Ill. C-5632.

**Chief Installation Engineer,** mechanical graduate, to 45, four years' supervisory installation engineering work covering cooling, lubrication, fuels, exhaust, ventilation, and/or controls systems. Will analyze sales orders pertaining to installations, work with customers on installation problems, develop accessories or modifications of systems, prepare mock-ups, trouble-shoot field engineering problems for a manufacturer of mechanical power. To $11,500. Employer will pay fee. Wis. C-5638.

**Production Engineer,** mechanical graduate, at least five years' experience in production or manufacturing engineering using machine-shop, forging, casting, welding, and heating operations. Will review drawings for manufacture, review changes, prepare procedures, review materials, investigate substitutions, and generally see that projects and parts are made as required for a manufacturer of mechanical power. To $10,000. Employer will pay fee. Wis. C-5639.

**Project Engineer,** mechanical graduate, at least five years' experience in project work in engine or related industry. Will write work orders so manufacturing departments can do their work, obtain special information, co-ordinate operations between departments, maintain project files, progress reports, prepare estimates, approve change orders, order experimental material, and maintain schedules for a manufacturer of mechanical power. To $10,000. Employer will pay fee. Wis. C-5640.

**Senior Experimental Engineer,** mechanical graduate, at least five years' experience in experimental or developmental work in engines or allied equipment. Will formulate test procedures, direct subordinates, compute results, analyze data, write reports and charts, maintain laboratory equipment, and learn to operate all test equipment, for a manufacturer of mechanical power. To $10,000. Employer will pay fee. Chicago, Ill. C-5641.

**Designer,** civil or mechanical, 30–45, at least five years' experience in design of heavy structures for heavy machinery; knowledge of cranes, trucks, gears, etc. Will be design engineer on overhead cranes for manufacturer of heavy machinery. $6900. Employer will pay fee. Wis. C-5665.

# Actions of the ASME Executive Committee

## *At a Meeting at Headquarters, Sept. 17, 1956*

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held, Sept. 17, 1956, in the rooms of the Society. The Committee recessed at noon to attend a luncheon at the Hotel Statler at which the 1956 Gantt Medal was conferred formally upon Henning W. Prentis, Jr. The meeting was reconvened in the afternoon.

There were present: Joseph W. Barker, chairman; F. L. Bradley, F. W. Miller, A. C. Pasini of the Executive Committee; J. L. Kopf, treasurer, and ASME representative on UET; E. J. Kates, assistant treasurer; H. J. Bauer, chairman, Finance Committee; W. F. Ryan, president-nominee; D. W. R. Morgan, past-president; W. H. Byrne, vice-president; E. O. Bergman, director; H. C. R. Carlson, director; Joseph Pope, director; E. G. Bailey, past-president and ASME representative on Task Committee on New Engineering Societies Building; F. Thompson and H. E. Martin, ASME representatives on UET; C. E. Davies, secretary; D. C. A. Bosworth, T. A. Marshall, Jr., O. B. Schier, 2nd, assistant secretaries; and Ernest Hartford, consultant. Louis Polk, member of the Executive Committee was unable to attend because of illness.

***Dues of Members in Foreign Countries.*** A policy regarding dues of members in foreign countries has been in effect since Nov. 25, 1945, and has received annual action since. Accordingly, the Executive Committee of the Council voted that for countries other than Mexico, the following policy regarding payment of dues of members in foreign countries, as approved by the Executive Committee of the Council on Nov. 25, 1945, be extended for another year: (1) That the Society adopt a policy requiring all dues to be paid in United States dollars; (2) if such payment becomes excessive, upon request, the Society may put the foreign member on suspended-dues list without service from the Society until such time as the Society may require him to pay his dues; (3) the young foreign student engineer who is in this country for one year may be permitted to pay the dues of a Student Member in order to have the privilege of receiving MECHANICAL ENGINEERING and attending meetings during his residence in the United States.

***Board on Technology.*** Upon recommendation of the Board on Technology, with the concurrence of the Organization Committee at its meeting on Sept. 6, 1956, the Executive Committee of the Council voted to authorize the formation of an ASME Solar-Energy Application Committee under the Board on Technology "to stimulate and develop a continuing program of Society activity dealing with the applications of solar energy" with the following personnel: J. I. Yellott, chairman; E. A. Allcut, L. J. Briggs, E. A. Farber, H. C. Hottel, R. C. Jordan, and W. T. Reid.

It was also voted to authorize the formation of a Technical Development Committee under the Board on Technology "whose duties shall be to promote the development of technical activities in the Society by (*a*) continuous surveillance of growth of scientific and engineering knowledge; (*b*) anticipation of the need of technical-society activity in new fields of work; and (*c*) recommending, when

deemed proper, the formation of new group activity within ASME to serve the Society's needs in new fields of work" with the following personnel: J. W. Barker, chairman; R. C. Allen; A. D. Bailey; E. G. Bailey; H. L. Dryden; J. A. Hutcheson; C. F. Kettering; W. E. Reaser; L. N. Rowley, Jr.; Philip Sporn; G. B. Warren; C. E. Williams; and J. I. Yellott.

***1957 EJC Nuclear Congress.*** Upon recommendation of the Board on Technology, at its meeting on Aug. 31, 1956, the Executive Committee of the Council voted to approve (1) participation in and sponsorship of the 1957 Engineers Joint Council Nuclear Engineering and Science Congress by ASME (recommended by the Nuclear Engineering Division, ASME); (2) operation of the 1957 EJC Nuclear Congress by ASME with the understanding that the Congress will be self-supporting financially; (3) co-operation of ASME with the International Atomic Exposition held in conjunction with the 1957 EJC Nuclear Congress.

***American Nuclear Society.*** On Sept. 7, 1956, the executive committee of the ASME Nuclear Engineering Division adopted two resolutions regarding co-operation with the American Nuclear Society. The Executive Committee of the Council voted to approve the following two resolutions adopted by the ASME Nuclear Engineering Division regarding co-operation with the American Nuclear Society; to request the ASME delegation on Engineers Joint Council to recommend to EJC that it encourage the American Nuclear Society in its work, co-operating with it, and that through proper agencies the ANS be encouraged to consider membership in EJC:

Resolution No. 1: (*a*) It is desirable for the EJC to authorize negotiations with the ANS aimed at including ANS in the Nuclear Congress in such a way that it enhances the prestige of ANS, in return for which ANS will plan only one national meeting per year instead of two as presently planned; (*b*) if this can be accomplished, the Nuclear Engineering Division of ASME will be happy to co-operate with ANS in regional conferences; and (*c*) the Nuclear Engineering Division feels that regardless of settlement, EJC Conferences on Nuclear Energy are vital to the field of nuclear engineering, and this Division intends to support them strongly.

Resolution No. 2: The Nuclear Engineering Division proposed that the Executive Committee of the ASME Council recommend that EJC recognize that ANS is a professional society which is established and is of considerable stature; that ANS can serve the professional disciplines a useful function through cross-fertilization of nuclear fields; and that EJC encourage ANS in its work, co-operate with it, and urge ANS to join EJC.

***Board on Honors.*** Upon recommendation of the Board on Honors, at its meeting on Aug. 31, 1956, the Executive Committee of the Council voted to approve the following Awards for 1956:

Blackall Machine Tool and Gage Award, Orlan W. Boston, Fellow ASME, Ann Arbor, Mich., and William W. Gilbert, Mem. ASME, Schenectady, N. Y., for their paper, "Forces and Power Required to Turn Aluminum and Seven Alloys."

Charles T. Main Award, Marion John Balcerzak, Assoc. Mem. ASME, Evanston, Ill., for his paper, "The Modern High-School Program as a Preparation for Engineering Education."

Undergraduate Student Award, Amedeo John Morelli, Student Member, ASME, Bloomfield, N. J., for his paper, "Calculating Machines."

Arthur L. Williston Medal and Award, John A. Welsh, Student Member, ASME, Cambridge, Mass., for his paper "Building Character in Undergraduates."

Old Guard Prize, Joseph W. Jacobson, Student Member, ASME, E. McKeesport, Ill., for his paper, "Metallurgical Yield Stress Observation."

Topic for Charles T. Main Award. Upon recommendation of the Board on Honors, the Executive Committee of the Council voted to approve "A Critical Analysis of Student Chapters of the National Engineering Societies" as the Charles T. Main topic for 1957.

***Appropriation for Presidential Expenses.*** The Nominating Committee, on June 18, 1956, voted "that the Budget Committee be requested to provide presidential expense allowances that are realistic, thus eliminating one of the difficulties facing the Nominating Committee when selecting a nominee for the office of President."

President Barker reported correspondence with the recent past-presidents about the expenses they incurred during their terms. Extensive discussion brought out the difficulty of determining the amount of money which should be established as regular annual figure for presidential travel. It was recommended that a reserve be established for this purpose with a fixed annual amount in the budget each year somewhat larger than the President is allowed.

As a guide to the Nominating Committee in approaching candidates for the presidency, the Executive Committee of the Council voted to adopt as a policy that the Society is to pay the actual and necessary travel expenses of its President.

***Heat Transfer Division, Custodian Fund.*** Upon recommendation of the Heat Transfer Division, the Executive Committee of the Council voted to approve the establishment of a Custodian Fund of the Heat Transfer Division, in accordance with the Policy on Custodian Funds. The Heat Transfer Division anticipates putting into this Fund the net receipts from the Industrial Exhibit to be held in connection with the forthcoming Division Conference at Pennsylvania State University, Aug. 11–14, 1957.

***Sections.*** Upon recommendation of Vice-President A. C. Pasini, the Executive Committee of the Council voted to authorize the addition of Richland County, Ohio, to the Canton-Alliance-Massillon Section.

Upon recommendation of Vice-President F. W. Miller the Executive Committee of the Council voted to authorize the Delaware Section to become a member of the Delaware Council of Engineering Societies in accordance with Article R11, Rule 7 pertaining to Section affiliation with local engineering organizations.

***Certificates of Award.*** Upon initiation of their associates, and upon approval of their respective vice-presidents, Certificates of Award have been granted to the following retiring chairmen of Sections: Birmingham, James W. Sloan; Central Indiana, F. A. Ryder; Columbus, H. Hazard; Kansas City, R. Benninghoven; and San Francisco, F. Wendell Beichley.

A Certificate of Award was granted to H. W. Robb, of Schenectady, N. Y., for outstanding leadership in the development of standards formulated under ASME sponsorship.

Upon recommendation of the Boiler and Pressure Vessel Committee, approval was voted for granting of Certificates of Award to C. E. Bronson, retiring member of Subcommittee on Heating Boilers, 1935–1956; and William Ferguson, retiring member of Subcommittee on Heating Boilers, 1939–1956, and of Subcommittee on Miniature Boilers, 1945–1956.

***ASME Representative on Planning Committee.*** The Secretary reported a communication from Dean J. H. Shera of the School of Library Science, Western Reserve University, Cleveland, Ohio, suggesting that the Society be represented on a Planning Committee on the Practical Utilization of Recorded Knowledge. The Executive Committee voted to appoint Colin Carmichael, of Cleveland, Ohio, to serve as ASME representative on that committee.

***Iron Ring Ceremony, Calling of an Engineer.*** At the ASME Business Meeting in Cleveland, June 18, 1956, it was moved "that the President appoint a committee to consider adoption, possibly by ASME, possibly by EJC, of some ceremony analogous to the Canadian ceremony, the Calling of an Engineer." Upon recommendation of President Barker, the Executive Committee of the Council voted to designate the following a committee to consider the adoption, by ASME or EJC, of a ceremony analogous to the Canadian ceremony, the Calling of an Engineer: A. C. Pasini, chairman; D. W. R. Morgan; G. A. Stetson; E. W. O'Brien; and F. S. Blackall, jr.

***New Engineering Societies Center*** At its meeting on July 3, 1956, the Executive Committee approved the report of the Special Task Committee on the new Engineering Societies Center and recommended approval by the Council in letter-ballot closing July 31, 1956. The Secretary reported that the 22 members of the Council unanimously approved the report.

The Secretary reported that the report of the Special Task Committee had also been approved by the boards of the American Society of Civil Engineers, the American Institute of Mining, Metallurgical, and Petroleum Engineers, and the American Institute of Electrical Engineers. The American Institute of Chemical Engineers approved recommendations 1 and 2 of the Task Committee report which provided that the proposed center be located in New York City on the present site. As the three other recommendations of the Task Committee were directed to the United Engineering Trustees of which AIChE is not a member, its Board withheld action thereon but appropriated $10,000 for the engineering study of the proposed center.

On Aug. 9, 1956, the UET approved a procedure whereby the American Institute of Chemical Engineers could become a member body of the UET and forwarded it to the four Founder Societies for approval.

The Board of the AIChE on Sept. 8, 1956, reported its inability to accept the conditions proposed and appointed a committee for further negotiation with UET. After intensive discussion of various possible procedures by which AIChE might become a member body of UET and with full realization that such a procedure would set a pattern for the admission of additional societies, the Executive Committee of the Council, for the guidance of the ASME representatives on UET, voted to instruct the ASME representatives on UET to proceed with the negotiations with the American Institute of Chemical Engineers, the general guiding principle to be that the policies and procedures should promote the unity of the engineering profession.

The Executive Committee of the Council adopted a resolution discharging the Special ASME Task Committee, at their request, with sincere thanks.

***ASME Representatives' Report to ECPD.*** Upon recommendation of the Board on Education and Professional Status, the Executive Committee of the Council approved the formal report of ASME representatives on Engineers' Council for Professional Development for presentation at the annual meeting of ECPD, to be held in Detroit, Mich., Oct. 25–26, 1956.

***Charles Franklin Kettering Award.*** It was recommended that a Charles Franklin Kettering Award be established as of Aug. 29, 1956, his eightieth birthday, and presented to him on Oct. 4, 1956, at the fall general meeting of the American Institute of Electrical Engineers, of which he has been a member for 52 years. By letter-ballot, the Executive Committee of the Council approved (1) making the first Kettering Award to Charles F. Kettering in Chicago, Ill., Oct. 4, and (2) authorizing the appointment of two representatives to a joint board to administer subsequent Kettering Awards. E. G. Bailey and J. W. Barker were appointed ASME representatives on the Charles Franklin Kettering Board of Award.

***Arthur M. Greene, Jr. Legacy.*** The Society received a legacy in 1954 from the estate of Arthur M. Greene, Jr. In 1955 a payment on account of the ultimate disposition of the estate was received by the Society. On July 30, 1956, the Society received a check representing "its distributive share of the last substantial distribution to be made under Dean Greene's will."

***Joint Awards.*** Awards, in which the Society participates jointly, have been made in 1956 as follows: John Fritz Award, Ben Moreell; Hoover Award, Herbert Hoover, Jr.; Daniel Guggenheim Medal, Frederick B. Rentschler (posthumously).

***Deaths.*** The Secretary reported the deaths of the following: E. H. Whitlock, July 4, 1956, vice-president, 1933–1935; W. J. Wohlenberg, Aug. 8, 1956, vice-president, 1942–1944; H. C. Boardman, Aug. 6, 1956, chairman, Boiler and Pressure Vessel Committee; and Sir Henry Guy, July 20, 1956, Fellow ASME, former Secretary, The Institution of Mechanical Engineers.

The Secretary reported, with deepest regret, the death on August 16, of Katherine W. Clendinning, managing editor, who was associated with the Society for almost forty years.

***Appointments.*** The Executive Committee of the Council, upon recommendation of the Organization Committee, approved appointments on Boards, Committees, and Joint Activities. (These appointments will be listed in ASME Annual, AC-IO, Personnel of Council Boards, and Committees, to be issued early in 1957.)

The Executive Committee noted the following appointments of presidential representatives; Ninth International Congress on Applied Mechanics, Brussels, Sept. 5–13, 1956, H. L. Dryden, J. M. Lessells, R. D. Mindlin, and W. M. Newmark.

Dedication of Westinghouse Research Laboratories, Pittsburgh, Pa., Sept. 20, 1956, R. J. S. Pigott.

Tellers of Election of 1957 Officers, R. W. Flynn, L. C. Morrow, and A. R. Mumford.

# Candidates for Membership and Transfer in ASME

THE application of each of the candidates listed below is to be voted on after Nov. 23, 1956, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

## New Applications and ●Transfers

### *California*

● BUDNEY, GEORGE S., Burbank
CARDER, VICTOR H., Santa Clara
CONFORD, MARVIN G., Monrovia
EIGE, JOHN J., San Francisco
NEWELL, JOHN B., Ventura
●NOLL, GERALD O., Alhambra
● WRIGHT, HAROLD M., Monterey

### *Colorado*

MEDLIN, WILLIAM W., Denver
TREVERTON, WARD R., Denver

### *Connecticut*

BIRDSEYE, JOHN H., Stratford
FRUTKOFF, CARL M., Middletown
● KING, CHARLES, Wilton
SKOVE, PHILIP W., Darien

### *Delaware*

COBBLER, MILAN H., Newark
EVANS, CLARENCE H., Wilmington
OBERLIN, ROBERT E., Wilmington
● QUILLMAN, BARD, Wilmington
TURNER, GEORGE E., Wilmington

### *District of Columbia*

CHO, SUNG HO, Washington
MILLER, MAURICE L., Washington
RUDOLF, GARDNER W., Washington

### *Flordia*

● HOWLAND, CHARLES S., JR., Jacksonville

### *Idaho*

NELSON, MARVIN L., Boise

### *Illinois*

BELINKOFF, IRVING L., Maywood
DRAUS, RICHARD F., Chicago
JUN, FRANK G., Downers Grove
LEVALLEY, JOHN R., JR., Chicago
MITCHELL, WILLIAM A., Morton Grove
● NOBLE, JOHN J., La Grange Park
SINCLAIR, GEORGE M., Urbana

### *Indiana*

CONNELL, NORMAN H., Mishawaka
NEWPORT, HAROLD L., Brazil
● REICHERT, HERMAN A., Michigan City
YANG, KWANG-TZU, Notre Dame

### *Kentucky*

RANGE, CLARENCE L., Louisville

● Transfer to Member or Affiliate.

### *Louisiana*

BAILEY, FRED W., Shreveport
BYWATER, GEORGE P., New Orleans
DYER, JULIUS C., JR., Baton Rouge
LEA, MAXWELL A., Baton Rouge
PIETROCARIO, JOSEPH A., New Orleans

### *Maryland*

CAMPBELL, MELVIN R., Baltimore
ELLIOTT, ERLE, Frederick
KREISSIG, JACOB F., Frederick
LARSON, EUGENE P., Frederick
● LASSAHN, EDWARD D., Baltimore
MURPHY, THOMAS V., JR., Baltimore
● NITKA, WILLIAM A., Baltimore
PARKER, EDWARD H., Baltimore
PEARRE, O. JACKSON, Union Bridge
PIASECKI, LOUIS J., Timonium
● WAGNER, ROBERT J., Baltimore

### *Michigan*

● CUMMINGS, EUSTACE W., Saginaw
EK, ROBERT W., Inkster
GAFFNEY, THOMAS P., Bay City
ORMES, DAVID W., Detroit
PIERCE, THOMAS H., Saginaw
SCHRENK, WALTER J., Bay City
SUNG, CHIEN B., Oak Park

### *Minnesota*

● HUNEGS, JAMES, Minneapolis

### *Mississippi*

MILLER, RANDALL J., Moss Point

### *Missouri*

● BURTON, RALPH A., Columbia
RAMPT, GEORGE W., JR., Kansas City
SCRUGGS, EDWARD B., St. Louis

### *Nebraska*

● HERMAN, OSCAR H., JR., Lincoln
● NEWHOUSE, KEITH N., Lincoln

### *New Jersey*

BRYERS, RICHARD W., Leonia
CRANMER, LOUIS W., Camden
● HUNT, HENRY C., JR., Readington
● NOWAK, FRANK J., North Haledon
THACKER, GEORGE W., River Edge
THWING, JOHN W., Ridgewood

### *New Mexico*

FOLEY, JEREMIAH T., JR., Albuquerque
HOLDEN, ROBERT W., State College

### *New York*

● ANTIERI, S. LOUIS, Brooklyn
BRENNER, LESLIE H., Elmhurst
BROWNING, WILLIAM W., Wellsville
BUCHSBAUM, FRANK, Kew Gardens
● BURRIS, ROY E., JR., Schenectady
CLAUSER, HENRY R., New York
CRONK, ROBERT D., Wellsville
FITZROY, NANCY D., Schenectady
FLAHERTY, EDWARD H., Olean
● GILLIGAN, STEPHEN V., Syracuse
● GILOTH, ROBERT P., Bedford Village
GRIFFIN, JOHN J., Huntington

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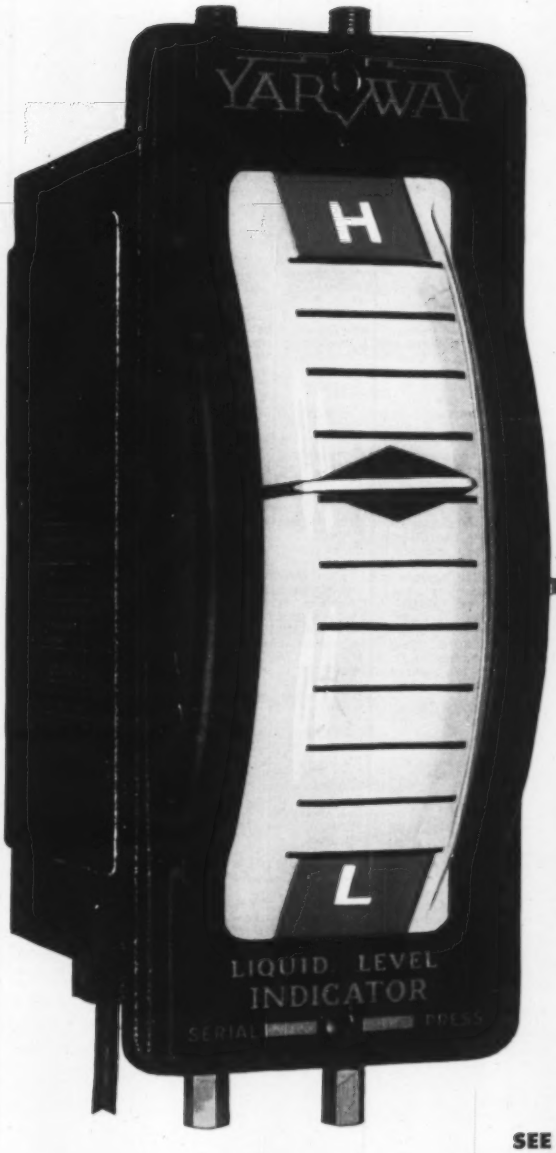
# this is "life insurance" for boilers

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YARWAY's new "wide vision" face gives brilliant readings from any angle . . . and the pointer is always visible, even at extreme high and low water levels.

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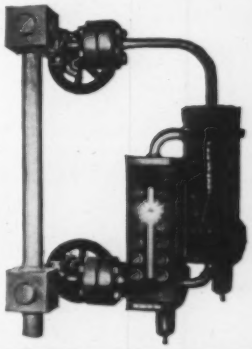

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HAZLETT, IRVING L., Wellsville
HEINMILLER, PAUL R., Schenectady
HOPPE, PAUL J., Wellsville
HUBBARD, FRANK L., Wellsville
KEENAN, DONALD B., Utica
LEVINE, ARTHUR L., Brooklyn
LEVINE, SOL, Bayside
NEIGHBORGALL, ROGER B., New York
OWENS, RAYMOND L., Buffalo
PETERSON, DEAN M., Rochester
REYNOLDS, ALEX J., Utica
● ROBBINS, JOSEPH E., New York
● SHAY, G. CLINTON, Corning
STEVENS, WILLIAM D., New York
STEVENS, WILLIAM G., Endicott
TERMIN, ALBERT, Bellerose
TONKIN, CHARLES W., JR., Tonawanda

### North Carolina

ANDERSON, HAROLD W., Statesville
HINTON, CHARLES V., Charlotte
● MASON, WILLIAM W., Greensboro

### Ohio

● DUNN, THOMAS J., Marion
HARVEY, JOHN F., Barberton
● HYLER, WALTER S., Columbus
MENDEZ, FRANK S., Akron
SEVCIK, JOSEF K., Wyoming
SHINE, ROBERT H., Dayton

### Oklahoma

CULBERTSON, W. LEROY, Bartlesville
DOYLE, HARRY E., Bartlesville
KIRK, ELMER L., Tulsa

### Oregon

MCGREGOR, DONALD D., Portland

### Pennsylvania

● ATHERTON, RICHARD, Pittsburgh
CLUGH, CLAIR I., Altoona
CONNELL, LEO F., Wynnewood
● CURTIS, LITTLE PAUL, East Pittsburgh
FISCHER, WILLIAM H., Pittsburgh
● FOLTZ, CHARLES J., Haventown
HEALY, WILLIAM L., Philadelphia
JOHNSON, WILLIAM P., JR., Erie
● KENNEDY, FRANK, Levittown
● NEWMAN, CARL L., Philadelphia
SEIDLER, EDWIN H., Export

### Tennessee

PERKINS, CHARLES H., Knoxville
● TOOMER, LAMAR C., Oak Ridge
● YOUNG, SAMUEL A., Kingsport

### Texas

ABBOTT, HARVEY M., Bellaire
ALLEN, EDWARD C., Houston
BOYD, WILL E., Houston
COLLIER, SAMUEL L., Houston
HAGAN, SANDY W., JR., Houston
HARRIS, JOHN W., Houston
WILLIAMS, WILLIAM L., 3RD, Houston

### Virginia

TOOMEY, JOHN B., JR., Alexandria

### Washington

● FELTS, WOODROW R., Richland
TSOW, ROBERT H., Spokane

### West Virginia

DZURENDA, MICHAEL L., Charleston

### Wisconsin

● STEELE, ROGER L., Wisconsin Rapids

### Foreign

ALEJANDRE, MIGUEL, Mexico, D.F., Mexico
BROOKE, RAYMOND, Sarawak, Borneo
CAMPOS D, ARTURO, Mexico, D.F., Mexico
CAMPOS D, FRANCISCO, Mexico, D.F., Mexico
CAMPOS D, GERMAN, Mexico, D.F., Mexico
CAMPOS D, RAUL, Mexico, D.F., Mexico
CHAUVIN, ALDEN E., Falcon, Venezuela
GAMBLING, GEOFFREY T., Toronto, Ont., Canada
GANESHA-RAO, HOSUR M., Bombay, India
HOUGHTON, GEORGE L., Toronto, Ont., Canada
JARVIS, IVOR M., Worcester, England
KHATIB, IBRAHIM A. K., Kuwait, Arabia
LYONS, RAYMOND R., Wailuku, Maui, T.H.
MARVEL, NATHANIEL T., Falcon, Venezuela
QUOJANI, MARCELLO, Rome, Italy
TORRA, JOSE R., Camaguey, Cuba
WATKINS, ERNEST R., Warwickshire, England
WOOD, DEREK, Toronto, Ont., Canada
YARON, TEODOR, Haifa, Israel

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# Obituaries

**George Bergen Bashen (1887–1956),** retired in 1950 after 40 years with Commonwealth Edison Co., Chicago, Ill., died July 26, 1956, at his home in St. Petersburg, Fla. Born, Bowen, Ill., Feb. 22, 1887. Education, BS, University of Illinois, 1910. Mem. ASME, 1939. Survived by wife, Elspeth N. Bashen; son, George W., Houston, Texas; two daughters, Mrs. John L. Wier, Naperville, Ill., and Mrs. Marshall H. Switzer, Glen Ellyn, Ill.; and six grandchildren.

**Maurice Frink Benfer (1904–1956),** estimator, Ladish Co., Cudahy, Wis., died June 11, 1956. Born, Elkhart, Ind., Sept. 24, 1904. Parents, Zino F. and Maude F. Benfer. Education, BS-(ME), University of Wisconsin, 1927. Jun. ASME, 1927.

**Harry Clow Boardman (1887–1956),** director of research, Chicago Bridge & Iron Co., Chicago, Ill., died Aug. 6, 1956. Born, Plainfield, Ill., April 29, 1887. Parents, George B. and Mary (Clow) Boardman. Education, BS, University of Illinois, 1910; CE, 1926; hon. DE, South Dakota School of Mines, 1943. Married Bessie McCumber, 1923. Mem. ASME, 1939; Fellow ASME, 1955. Since 1954 he had been chairman of the ASME Boiler and Pressure Vessel Code Committee. He was a member of this committee for over 20 years and served on many of its important subcommittees. In 1939 he was president of the American Welding Society and in 1950 was chairman of the Welding Research Council. He was active in several other leading professional societies. He was the recipient of the AWS Miller Medal in 1942. He served as chairman of the Welding Handbook Committee, Third Edition. Also author of many technical papers and "Handbook of Arcs, Chords, and Versines." Held 27 U. S. Patents pertaining to various types of vessels and welding processes. Survived by his wife, three sisters, and a brother.

**Harry Stephenson Bowen (1892–1956?),** whose death was recently reported to the Society, was president, Puget Sound Fabricators, Inc., Seattle, Wash. Born, Seattle, Wash., March 4, 1892. Parents, David W. and Nettie (Stephenson) Bowen. Education, high-school graduate; New York Trade School; one year, University of Illinois. Married Bess Hessett, 1914; three children. Jun. ASME, 1931; Mem. ASME, 1935.

**Bennett Wellington Cooke (1889–1956),** president, Coyne Electrical School, Chicago, Ill., died May 4, 1956. Born, Mansfield, Ohio, Oct. 30, 1889. Education, high-school graduate; 2 years, University of Illinois; 1 year, Columbia University. Affiliate ASME, 1924. He was a member of AIEE, SAE, and the Western Society of Engineers.

**Frank Patrick Corrigan (1893–1956),** assistant superintendent, Electric Production Division, Cincinnati Gas & Electric Co., New Richmond, Ohio, died July 6, 1956. Born, Sadieville, Ky., July 2, 1893. Education, St. Joseph College, Cincinnati, Ohio, 1911–1914; Ohio Mechanic Institute (night school), 1923–1925. Mem. ASME, 1946.

**Byron William Dunham (1877–1955),** chief engineer, Edgewater Steel Co., died Dec. 2, 1955, at his home in Oakmont, Pa. Born, Oshtemo, Mich., Sept. 18, 1877. Education, BS, Kalamazoo College, 1903; BS(ME), University of Michigan, 1905. Mem. ASME, 1914.

**Morris Greenberg (1896–1956),** mechanical engineer, Mid-West Heat Service, Chicago, Ill., died May 22, 1956, as the result of an automobile accident. Born, Devils Lake, N. Dak., June 10, 1896. Education, BS(ME), University of Minnesota, 1918. Mem. ASME, 1940. Author of several technical papers published in professional journals.

**Sir Henry Lewis Guy (1887–1956),** who until his retirement due to ill health in January, 1951, had been secretary of the Institution of Mechanical Engineers (Great Britain), and more recently a consulting engineer, residing at Enniskerry, Cranford Cliffs, Bournemouth, England, died July 20, 1956. Born, Penarth, Glamorganshire, June 15, 1887. Parents, Richard and Lettia (Lewis) Guy. Education, Penarth Country School; Cardiff College, University of Wales, Diploma Mechanical Engineering, Diploma Electrical Engineering (he studied for these diplomas simultaneously); hon. DS, University of Wales, 1939; Whitworth Exhibition; F.R.S. Married Margaret Paton Williams, 1914; children, Betty M. Gill and Joan D. Dear. Mem. ASME, 1930; Fellow ASME, 1944. His various inventions include the improvement of steam turbines, condensers, and auxiliary plants. Author of numerous papers relating to development of steam turbine power plant. He was the recipient of Hawksley Gold Medal and Parsons Memorial Medal; Fellow, Royal Society; CBE (Commander of the distinguished order of the British Empire); hon. mem., IME; hon. mem., Belfast Engineering Society; and hon. assoc., Manchester College of Technology; president and trustee, Whitworth Society. He served as chairman of the Engineering Research Committee of the National Physical Laboratory; chairman of several committees of the British Standards Institution. Just prior to World War II, in 1939, he was appointed a member of the Advisory Council on Scientific Research and Development of the Ministry of Supply, and later became chairman of its Gun Design Committee and of its Static Detonation Committee (Bombs). Early in the war he was appointed, by the Minister of Supply, chairman of the Committee on Armament Development; by the Minister of Aircraft Production, chairman of a committee to report on the work and staffing of the Royal Aircraft Establishment, and chairman of a committee to report on the organization of "Aircraft Armament Research and Development"; by the Army Council, chairman of the committee on "Technical Organization of the Army," and chairman and member of various postwar committees of the Ministry of Supply's Scientific Advisory Council. He was an associate member of the Board of Chemical Warfare and an associate member of the Ordnance Board until 1949. He served the postwar government on many committees dealing with engineers and engineering. Survived by wife and two daughters.

**George Elliott Hallenbeck (1877–1956),** retired in 1952, having served as president, member, and later chairman, board of directors, Baker Bros., Inc., Toledo, Ohio, died May 27, 1956. Born, Canandaigua, Mich., June 9, 1877. Parents, Elliott and Margaret (Murphy) Hallenbeck. Education BS(ME), Purdue University, 1900. Married Lydia M. Smedley, 1914; Children, Thomas L. and Jane Elliott. Mem. ASME, 1908. Held numerous patents on machine tools.

**Oluf Bernhard Hagerup Hansen (1878–1956),** superintendent and chief engineer, Lehman Brothers, New York, N. Y., died April 24, 1956. Born, Tromso, Norway, Oct. 31, 1878. Parents, Kristian and Pretrica Hansen. Education, high-school graduate; four years, technical evening school; Diploma "C," Marine Engineering, Academy of Arts and Sciences, Rotterdam, Holland, 1913. He held licenses as chief engineer on ocean-going steam and motor vessels. Mem. ASME, 1948.

**William Adam Herr (1894–1956),** senior engineer, Philadelphia Electric Co., Philadelphia, Pa., died June 2, 1956. Born, Philadelphia, Pa., Dec. 29, 1894. Parents, Mr. and Mrs. William Herr. Education, 11 years evening school, Temple University, Drexel Institute, and Columbia University. Married Elsie A. Ernst, 1918. Assoc-Mem. ASME, 1922; Mem. ASME, 1928. Author of technical papers covering test results of underground soil temperatures surrounding steam lines, demand controllers for heating systems, and air preheaters. Survived by wife.

**Douglas Preston Kennedy (1894–1956),** a consulting engineer and retired sugar plantation official of Arlington, Va., died July 18, 1956. Born, Scranton, Pa., Oct. 1, 1894. Education, graduate McKinley Technical High School; attended George Washington University. He went to Puerto Rico originally as a chemist with the South Puerto Rico Sugar Co. and from there to the company's Santo Domingo branch where he was a factory superintendent. He was manager of four sugar plantations of the West Indies Sugar Corp. when he retired in 1947 and returned to Arlington, Va., as a consulting engineer. Mem. ASME, 1928. Survived by wife, Ruth Elizabeth (nee Magill); his father, William A. Kennedy, Arlington, Va.; and a sister, Mrs. Helen D. Chamberlain, Memphis, Tenn.

**Edward Kerr (1893–1956),** vice-president, Davey Co., Downingtown, Pa., died July 8, 1956. Born, Downingtown, Pa., May 13, 1893. Education, 3 years, West Chester State Normal School; 3 years, University of Pennsylvania, class of 1914. Mem. ASME, 1928. He was a specialist in the design and construction of

*(ASME News continued on page 1094)*

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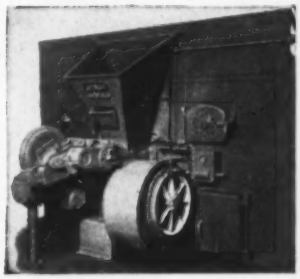

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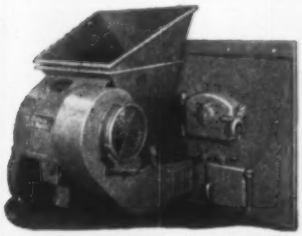

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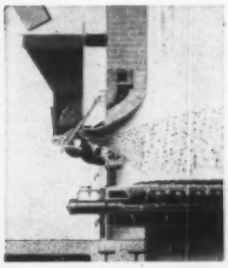

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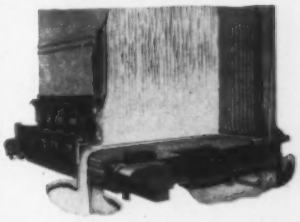

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**Allen Moore Lindsley** (1895–1956?), whose death was recently reported to the Society, was head planning and methods engineer, Wilson and Co., Inc., Chicago, Ill. Born Cincinnati, Ohio, July 19, 1895. Education, ME, University of Cincinnati, 1920. Mem. ASME, 1945. Author of several technical papers on producton control and time-study data.

**Robert Lowy** (1884–1956), who was commanding engineer, civil-engineering department, Pennsylvania Military Academy; associate professor, University of Pennsylvania, died in January, 1956. Born, Vienna, Austria, Jan. 12, 1884. Education, engineering diploma, Vienna engineering school, 1907; doctorate in technical sciences, technical school, 1909. Mem. ASME, 1940. He served the Society for several years on the Committee on Water Hammers. Author of numerous technical papers and textbooks in the field of hydraulics and held 15 European patents.

**Horace Greeley Moore** (1900–1956), assistant chief of equipment, Atlantic Coast Line Railroad Co., Wilmington, N. C., died June 16, 1956. Born, Americus, Ga., Aug. 10, 1900. Mem. ASME, 1949. Except for 2½ years overseas during World War II, when he served with the U. S. Army Transportation Corps at General Headquarters in Paris, he was employed by the Atlantic Coast Line Railroad.

**Ralph Neuhaus** (1896–1956), vice-president, Associated Oil Field Rentals, a division of Associated Oil & Gas Co., Houston, Texas, died June 16, 1956. Born, New York, N. Y., Sept. 14, 1896. Parents, George E. and Agnes Neuhaus. Education, ME, Cornell University, 1918. Jun. ASME, 1922; Mem. ASME, 1937. Married Sarah S. Radford, 1926; son, Ralph S. He held seven U. S. Patents pertaining to oil-well drilling equipment.

**Leo Matthew Nowacki** (1906–1956), assistant section engineer, General Electric Co., Schenectady, N. Y., died April 24, 1956. Born, Dunkirk, N. Y., Sept. 19, 1906. Education, SB(EE), Harvard University Engineering School, 1928. Associate, ASME, 1944. Author of papers on induction motors used as power selsyn units and held a patent on a control for this type of unit.

**Frederic Lexington Ruoff** (1892–1956), partner, Plibrico Sales and Service Co., division of Ruoff & Sons, Fort Wayne, Ind., died July 7, 1956. Born, Fall River, Mass., April 19, 1892. Parents, Charles F. and Sarah E. Ruoff. Education, ME, Cornell University, 1920. Married Gladys C. Hartman, 1922; two sons, Fredric L., 2nd, and David L. Mem. ASME, 1939. Served the Society as treasurer, Fort Wayne Section, 1939–1940; vice-chairman, 1940; and chairman, 1941.

**John W. Steinmeyer** (1886–1955), research engineer, American Car and Foundry Division of ACF Industries, New York, N. Y., died Dec. 30, 1955. Born, St. Louis, Mo., March 21, 1886. Parents, Gustave and Anna (Mueller) Steinmeyer. Education, high-school graduate; 2 years, Walter College, St. Louis; continued evening school courses in engineering and architecture for the four following years. Married Barbara Schmidt, 1910; two daughters, Ruth (Mrs. J.) Cook and Marie (Mrs. R.) Warntz. Mem. ASME, 1928. Held three U. S. Patents on railway-car appliances.

**Guy Julien Talbourdet** (1894–1956), mechanical engineer, Research Division, United Shoe Machinery Corp., Beverly, Mass., died June 23, 1956. Born, Lamballe, France, Sept. 4, 1894. Parents, Guillaume and Josephine Talbourdet. Education, French Navy Engineering School, 1913; attended both Lowell Institute and Wentworth Institute; BS, Massachusetts Institute of Technology, 1935. Naturalized U. S. citizen, Boston, Mass., 1935. Married Louise A. Mathias, 1920; children, Lucille M., Andre J., Guy J., and Marie T. Mem. ASME, 1940. A specialist in gear design and analysis of mechanical motion, he wrote several papers covering his work in this field; many of the papers were presented at Society meetings.

**John Franck Wolff, Jr.** (1896–1956), consulting engineer specializing in industrial plant design, Jenkintown, Pa., died Aug. 3, 1956. Born, Philadelphia, Pa., June 21, 1896. Parents, John F. and Emma K. Wolff. Education, BS(ME), University of Pennsylvania, 1917; ME, 1921. Married Evelyn Letson, 1926. Jun. ASME, 1918; Mem. ASME, 1952. For more than 25 years he had been associated with the staff of the evening school of the Drexel Institute of Technology; in 1935 he was appointed head of the mechanical-engineering department. Survived by wife; daughter, E. Roberta; and son, John K.

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From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Division (no more than three) in which you are interested. Your membership card bears key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you are registered.

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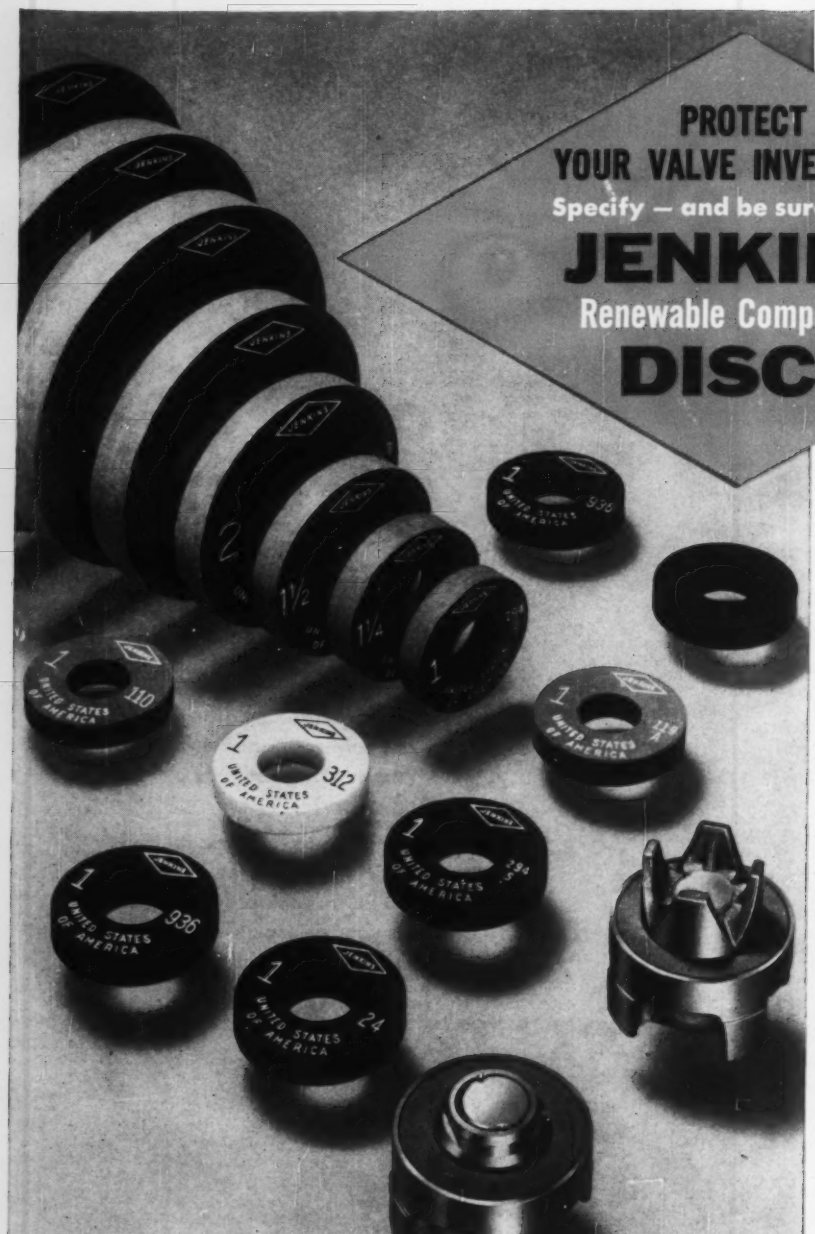


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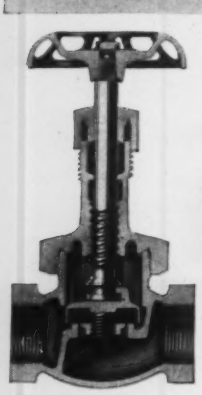

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11-56

***NOT GOOD AFTER DECEMBER 15, 1956***

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Read the various items listed . . . one catalog may hold the solution to your present problem . . .

### 1 CENTRIFUGAL PUMPS

**Allis-Chalmers Mfg. Co.**—Bulletin 52C6059 describes the company's diversified line of centrifugal pumps including units for handling clear liquid, corrosive or abrasive liquids, or liquids containing large percentages of solids in suspension.

### 2 DIHEDRAL COUPLINGS

**Ajax Flexible Coupling Co.**—Catalog No. 62 covers Series D-100 standard, floating shaft and mill motor type dihedral couplings. Working data is given on sizes, capacities and dimensions of the couplings which are designed to handle angular and offset misalignment up to a total of 12 deg.

### 3 CLOSED CELLULAR RUBBER

**Rubatex Div., Great American Industries, Inc.**—An 8-page catalog shows diversified applications, advantages, physical and thermal properties of Rubatex nitrogen-filled closed cellular rubber for sealing, gasketing, cushioning, vibration isolation and packaging applications.

### 4 SWIVEL JOINTS

**Emsco Mfg. Co.**—General catalog illustrates and describes line of ball bearing swivel joints for use on machine tool coolant lines, a gasoline dispensing hose, paint spray lines, hose, liquid and air handling equipment, and for purposes throughout the petroleum industry. Prices are included.

### 5 REPEAT CYCLE TIMER

**Eagle Signal Corp.**—Bulletin 323 describes a multipulse repeat cycle timer designed for such applications as sequence starting of several motors, timed sequencing of automatic cement block machines, sequence operation of solenoid valves in a washing process, or operation of a series of dampers in a dust-collecting system. The unit opens or closes as many as 12 circuits in sequence.

### 6 SPEED REDUCERS

**Westinghouse Electric Corp.**—Engineering manual gives information necessary to specify the correct speed reducer for particular applications. Selection, horsepower ratings, torque, capacities, overhung load values, dimensions, contructions, installation and maintenance data on single, double or triple reduction speed reducers are included in this booklet, B-6727.

### 7 CENTRIFUGAL PUMPS

**C. H. Wheeler Mfg. Co.**—Double suction single-stage centrifugal pumps are described in an 8-page bulletin. The pumps are recommended for general service wherever liquids of low viscosity are to be moved.

### 8 POWER SUPPLY

**Pace Engineering Co.**—A bulletin describes a regulated d-c power supply which is of the same size and may be substituted for 1.5 v dry cell batteries in self-balancing potentiometers and pyrometers. The regulating system is described briefly and specifications are given for stability against line voltage and other ambient variations.

### 9 PROCESS CONTROLS

**Powers Regulator Co.**—A 100-page general industrial catalog describes devices for industrial processes, domestic hot water control systems, and space temperature and humidity control. Pneumatic and self-contained temperature controllers; indicating, recording, and/or controlling temperature, pressure, and humidity instruments; diaphragm and bellows valves; push stem air motors; psychrometer and aspirator assemblies; steam traps; and air switches and relays are covered.

### 10 SPECIAL STEELS

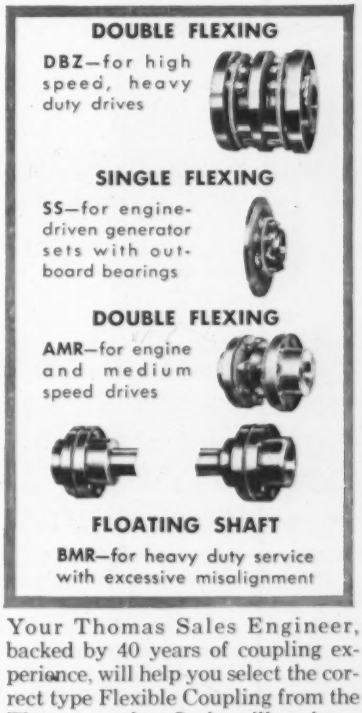
**Allegheny Ludlum Steel Corp.**—A 16-page booklet gives details on stainless steels, electrical materials, Carmet carbide materials and tool steels. Charts give analysis of various steels, and information on fabrication properties is included in the booklet.

### 11 WATER GAGE

**Yarnall-Waring Co.**—Bulletin WG-1814, describes new Color-Port water gage for high pressure boilers up to 3300 psi. Details are given on design and operation, and how the port-type arrangement and two-color readings give greater visibility.


**Coupling problem?**

**THOMAS will help select your coupling**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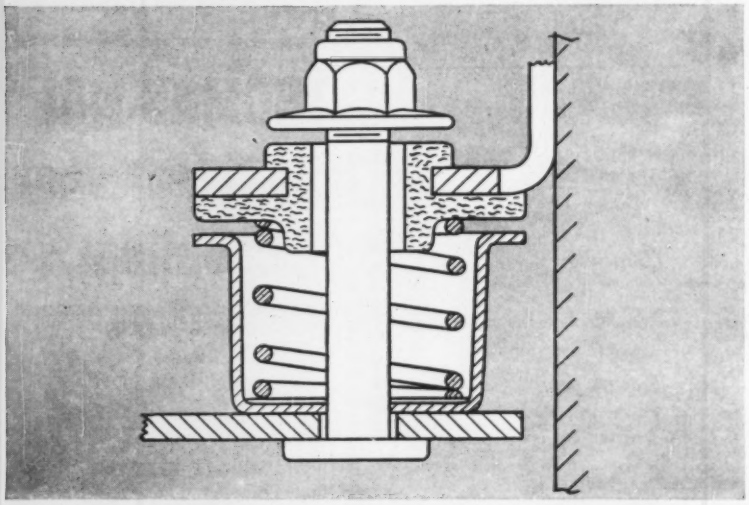
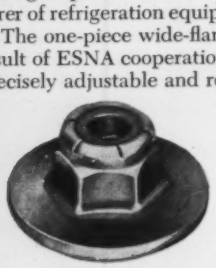
## FASTENER PROBLEM



# Special fastener eliminates field adjustment of spring-loaded mounting

There are two commonly used methods for fastening spring-loaded refrigerator/freezer compressor mountings: (A) Nut and lockwasher combination is tightened against the mounting bracket prior to shipment and subsequently backed off to a desired tension point by service personnel upon installation. (B) By means of an improved mount design illustrated above and a special rubber grommet, the nut assembly is adjusted at the factory to the proper tension and shipped ready for installation. With methods (A) and (B) the lockwasher was completely ineffective as a means of maintaining tension when tightened against the spring; and with method (A) the ordinary nut-lockwasher combination frequently loosened during shipment. ESNA Engineers recently received a request from a manufacturer of refrigeration equipment for a fastener to meet these specific requirements.

The one-piece wide-flanged Elastic Stop® nut Type 1994 (illustrated) is the result of ESNA cooperation with this manufacturer. The new nut is self-locking, precisely adjustable and reusable. It can be used for either method (A), where it also eliminates the lockwasher, or (B). Once adjusted at the factory, or tightened against the frame, the red locking collar holds the nut firmly in place, impervious to vibration during shipment or normal operation. Yet, if there is a need to dismount the compressor, the nut can easily be wrenched off and on, again and again, without affecting its efficiency.



ESNA Type 1994

**MAIL COUPON FOR DESIGN INFORMATION**

**Elastic Stop Nut Corporation of America, Dept. N14-1111**
**2330 Vauxhall Road, Union, New Jersey**

Please send me the following free fastening information:

☐ Standards drawing of mounting nut Type 1994

☐ Here is a sketch of our fastener problem. What self-locking fastener do you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone____ State_____


## YOUR *New Catalogs* GUIDE

### 12 VALVE OPERATORS

**Tork-Master Div., Harvill Corp.**—A brochure on features and application of automatic valve operators shows unique, patented design, to assure low-cost installation without altering new or existing valves, and without interrupting service.

### 13 LAPPING MACHINES

**Crane Packing Co.**—Literature describes Model 72 lapping machines. The spider bar and roller bar attachments have been improved and an ammeter has been added as standard equipment.

### 14 LIQUID METERS

**Rockwell Mfg. Co.**—Bulletin OG-411 describes large capacity Rotocycle meter line with new crank control design. Pictures and exploded view illustrate new simplified rotor measuring element now used in the 400, 600, and 1000 gpm meters.

### 15 POWER TRANSMISSION PRODUCTS

**Boston Gear Works**—A 576-page, pocket-sized catalog contains information on 7,124 standardized power transmission products. More than 50 pages of engineering data are included.

### 16 EXPANSION ROOF TANKS

**Graver Tank & Mfg. Co.**—Gasoline terminal losses, including those losses due to evaporation of product, are the subject of a 4-page folder, illustrated by actual low-loss operating figures at terminals equipped with expansion roof tanks. At all these installations such losses are held to a fraction of one per cent.

### 17 AIR GAGES

**Sheffield Corp.**—Precisionaire catalog IPC-6-56 has 12 pages describing principle and application of air gaging with column-type instrument. It features basic tooling for inspecting internal and external dimensions and conditions, and types and sizes of adjustable air gage tooling. Illustrations of single and multi-dimension gage applications are included.

### 18 SEAMLESS ROLLED RINGS

**Alco Products, Inc.**—A bulletin illustrates and describes the firm's facilities for the manufacture of seamless forged and rolled rings. Four pages of tables on how to calculate ring weights are included, along with application photos.

### 19 WATER STORAGE

**Chicago Bridge & Iron Co.**—A 4-page pamphlet describes installation of three Waterspheroids for the city of Elmhurst, Ill. Water storage problem, the planning undertaken to solve it and the results of dependable storage reflected in reduced insurance cost and reliable pressure in the City's water system are discussed.

### 20 VAPOR CONDENSERS

**Niagara Blower Co.**—Bulletin No. 129R on Aero vapor condenser with diagrams and photographs shows new apparatus condensing vapors independent of a large supply of cooling water. Units illustrated cool reflux liquids and condense vapors at top of distillation towers. Other applications produce a higher vacuum when used to replace barometric type condensers in evaporating milk.

### 21 TEMPERATURE CONTROLS

**Fenwal Inc.**—Detailed folders describe devices for temperature detection, indication and control. Included are Thermoswitch and snap action local controls, remote bulb and capillary units, Detect-a-Fire and electronic thermistor controllers.

### 22 PIPING SYSTEMS

**Tube Turns**—A technical bulletin gives the allowable stresses as used in the formulas of the ASME Boiler Construction Code (1952), Section I, and in the ASA Code for Pressure Piping B31.1-1955. The objective of the various codes is to prescribe a standard of minimum requirements for safe design of piping systems in such fields as power, industrial gas and air, oil, district heating, refrigeration and gas transmission.

### 23 TUBE EXPANDERS

**Gustav Wiedeke Co.**—Catalog 81 contains specifications on the firm's line of tube expanders and cutters. Included are tables of sizes, ordering information and a list of domestic and foreign distributor locations.

YOUR

## New Catalogs GUIDE

### 24 COOLING TOWER

**Foster Wheeler Corp.**—A 4-page bulletin gives construction and operational details of a new type induced draft cooling tower. A three-dimensional drawing of a tower cell and perspective drawings of major equipment features are shown. Equipment shown includes water-mixer drift eliminators, full cone spray nozzles, double diamond fill racks, double lapped sheathing panels, bracing and anchoring system and all-redwood framing.

### 25 AUTOMATIC VALVES

**A. W. Cash Co.**—A four-page bulletin, No. S-730, illustrates and describes 27 items of standard automatic valves and controls. These items are a portion of the complete line designed to meet every type of control problem.

### 26 STEEL GRATING

**Blaw-Knox Co.**—A 28-page bulletin illustrates and describes electroforged steel grating and treads for plants, sidewalks, stairs. A table of safe loads is included.

### 27 HEAT EXCHANGERS

**Lummus Co., Heat Exchanger Div.**—Bulletin M-306 includes a description of the design specifications and construction details of standard heat exchangers for process industries. Tables of effective surface area available, overall dimensions, thermal design data are included.

### 28 DRAFTING MACHINES

**Charles Bruning Co.**—"The Finest in Drafting Machines," a 20-page illustrated booklet, explains the cost and time-saving advantages offered by drafting machines in mechanical drawing, and describes and illustrates models and construction features. A list of available scales is included.

### 29 STEAM TRAP PROBLEMS

**V. D. Anderson Co.**—Bulletin No. 151 entitled "Solving Steam Trap Problems," contains 36 pages of illustrations, drawings, and charts, describing the importance of trap selection and showing application for various industries.

### 30 KILN INSTRUMENTATION

**Leeds & Northrup Co.**—A 16-page folder illustrates and describes instruments and controls for rotary kilns used in the manufacture of cement, lime and other non-metallic products. Installation photos are included.

### 31 NEW METHOD OF LUBRICATION

**Stewart-Warner Corp., Alemite Div.**—Catalog describes new method of lubricating industrial machinery with "Oil-Mist." Bulk of publication taken up with engineering data, covering applications, operation, bearing application, bearing speeds of this method. Also for plain bearings, selection of condensing fittings, intermixing of condensers, bearing grooving and many other engineering data appropriate to the subject.

### 32 INSULATED PIPING

**Ric-Wil, Inc.**—A 24-page catalog, No. 56-1, describes prefabricated insulated piping for underground or overhead distribution of steam, oil, hot or chilled water, process liquids; large-diameter prefabricated conduits for housing all utility services; and various related equipment including conduit and pipe testing caps, insulation fittings for 90-deg elbows and unloading slings.

### 33 HEAVY DUTY COMPRESSORS

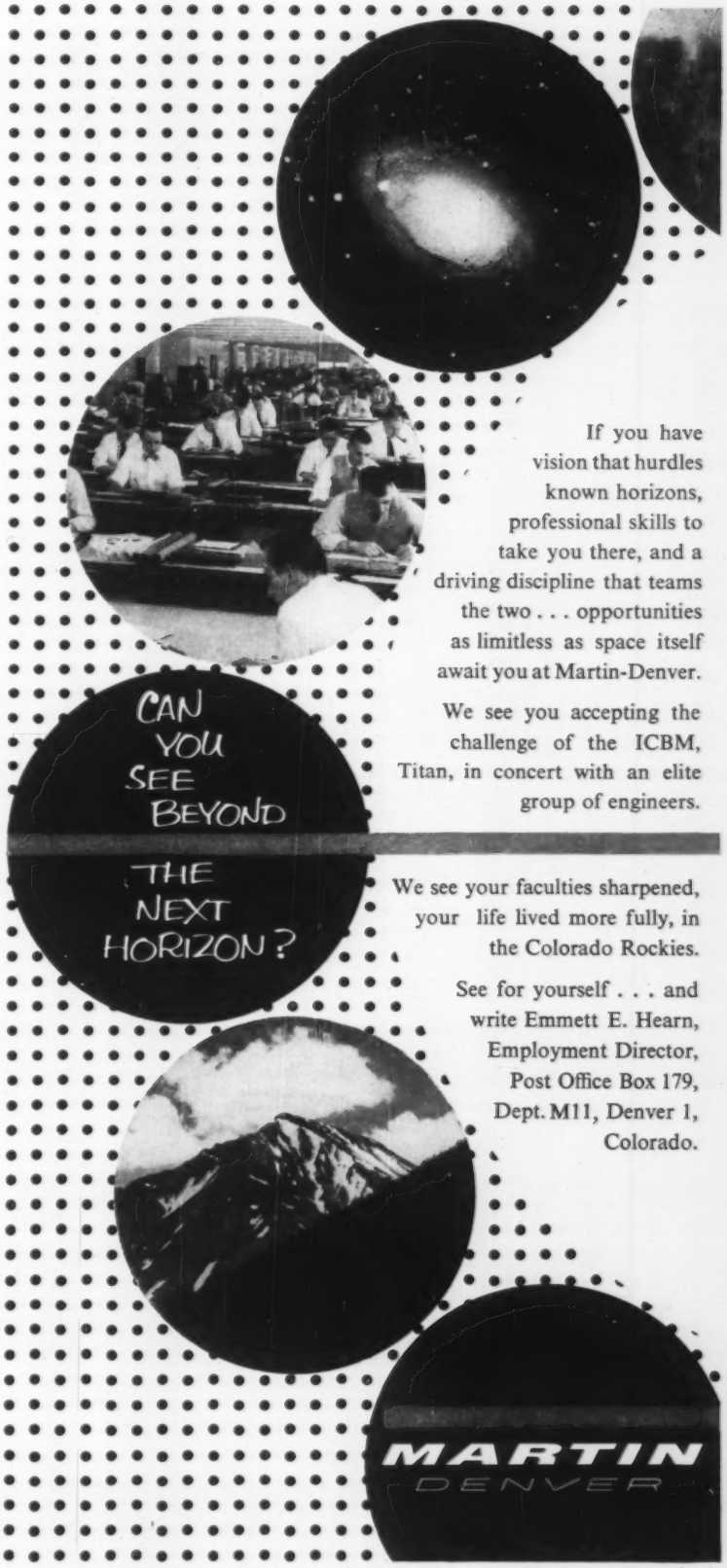
**Pennsylvania Pump & Compressor Co.**—Single stage, horizontal, water cooled, heavy duty air compressors in sizes from 10 to 125 hp and for pressures to 150 psig covered in Bulletin 201-E.

### 34 SAFETY, RELIEF VALVES

**Kunkle Valve Co.**—A 50-page catalog, No. 53, has selection indexes for steam, air-gas, and liquid ASME Std spring loaded safety valves for pressures to 5000 lb in brass, bronze, iron, and steel. Included are descriptions, dimensions, certified relieving capacities, and applications.

### 35 ELECTRONIC LOAD CELL SCALES

**Toledo Scale Co.**—Literature describes the new electronic load cell scales in which weight is transmitted electrically so the scale indicating or recording elements can be located wherever desired. The folder describes the advantages offered by these scales and suggests how they can contribute to a modern weight control system.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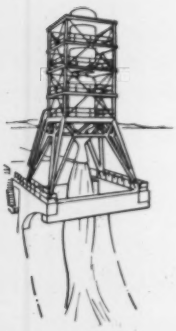

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YOUR

# New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

### 36 COAGULATOR

**Hungerford & Terry, Inc.**—A 16-page bulletin illustrates and describes a new coagulator which is a high speed upflow solids contact type coagulation and settling unit for use in water clarification, water softening and waste water treatment.

### 37 CONVEYING & POWER TRANSMISSION

**Link-Belt Co.**—A 340-page guide of the firm's standard lines of power transmission and conveying equipment contains data on chains for conveying and power transmission, ball and roller bearings, enclosed gear drives, clutches, couplings. One section lists conveyor and elevator components. Also listed are vibrating screens, car icing equipment, car spotters, and power unloading scoops. Tables of pre-selected assemblies, concise capacity charts and dimension tables for all standard products are included.

### 38 BOILERS AND STOKERS

**James Leffel & Co.**—Bulletin 236 gives descriptive and specification information and performance data on the firm's gas-, oil-, and coal-fired Scotch boilers and on underfeed stokers for use with Scotch boilers.

### 39 NON-REPRODUCING PENCIL

**American Lead Pencil Co.**—Sampler with pencil that has rounded hexagon, translucent colored lead for non-reproducible papers or masters is offered. The firm recommends it for making duplicate copies by Diazo process such as Bruning, Ozalid or similar equipment. It sharpens in any pencil sharpener and color will not fade or smear on master copies.

### 40 PIPING PRODUCTS

**Midwest Piping Co.**—A 192-page bound catalog illustrates and describes welding fittings, forged steel flanges, prefabricated piping, pipe coils. Comprehensive design and application data is included.

### 41 STEAM VALVE CALCULATOR

**Fulton Sylphon Div., Robertshaw-Fulton Controls Co.**—A slide rule card shows valve sizes required for heat and pressures of given quantities. The reverse side shows valve size required for given liquid flow. Also included is a guide to measuring the proportional pressure drop-capacity for saturated steam.

### 42 SELF-LOCKING SCREWS

**Standard Pressed Steel Co.**—A 16-page booklet on self-locking socket head cap and set screws describes self-locking insert, gives specifications and performance data on material. Sizes, dimensions and packaging information is included.

### 43 STEAM TRAPS

**Armstrong Machine Wks.**—A 44-page manual on condensate drainage contains data on semi-steel and forged steel traps, discusses the fundamentals of good trapping, and deals with trap selection problems, installation, repair and trouble shooting.

### 44 RUBBER, PLASTICS PRODUCTS

**General Tire, Industrial Products Div.**—Catalog No. 786 gives basic specifications and application data on molded and extruded rubber products and extruded polyvinyl chloride, polyethylene and modified pvc.

### 45 STORAGE WATER HEATERS

**Patterson-Kelley Co.**—A 48-page, 7-color catalog gives details of water heaters using steam or boiler water as heating medium. Specifications and construction details, material thickness and size tables allow selection of proper heater for any installation, whether ASME or non-ASME.

### 46 INDUSTRIAL FURNACES

**Bigelow-Liptak Corp.**—An illustrated, three-color catalog features the company's unit suspended walls and arches for industrial furnaces. Special designs for steel mills, open hearth, billet heating, heat treating, oil refinery, heaters, cat crackers, coal preparation, dryer furnaces, boiler settings are shown.

### 47 HYDRAULIC PRESSES

**Lake Erie Engineering Corp.**—Bulletin 1.1 describes hydraulic presses and die casting machines. It incorporates a comprehensive chart relating various types of presses to their production uses. Photos of representative presses and a selection chart are included.

### 48 PENCIL SELECTOR

**Eagle Pencil Co.**—A booklet explains the fundamentals of pencil quality and tells how to select the proper pencil for manifold forms, legal forms, duplicating machines, checking, marking, steno use, charting graphs, blueprint marking, drafting, and general writing.

### 49 ROLLER CHAINS

**Diamond Chain Co., Inc.**—Catalog 754 contains information on stock roller chains and sprockets. Selection of stock drives, calculation of chain lengths, installation recommendations, and speed ratio tables are some of the subjects covered in the 64-page catalog.

### 50 METAL STAMPINGS

**Bossert Div., Rockwell Spring & Axle Co.**—An 8-page folder illustrates and describes facilities for producing metal stampings and welded assemblies in any metal or alloy. Re-design service which can often recommend design improvements to simplify production and reduce manufacturing costs is described.

### 51 WROUGHT IRON PIPE

**A. M. Byers Co.**—A 48-page illustrated catalog covers wrought iron pipe and tubular products. Included are sections on properties, specifications, mill standards, product identification and ordering.

### 52 AUTOMATIC VALVES

**A. W. Cash Valve Mfg. Corp.**—60-page catalog describes and illustrates line of pressure reducing and regulating valves, relief valves, back pressure valves, vacuum regulators and vacuum breakers, differential pressure regulators, strainers, and diaphragm operated; control valves. Contains 16 new items not previously included in former catalogs.

### 53 BELLOWS ASSEMBLIES

**Clifford Mfg. Co.**—A file folder illustrates and describes representative bellows devices. Included is a chart detailing the sizes and characteristics of the 20 most commonly used bellows, and a comprehensive discussion of designing with metal bellows.

### 54 TEST BOILERS

**Besler Corp.**—A four-page folder covers features and advantages of high temperature, high pressure test boilers, designed to deliver steam at full operating pressure and temperature in two minutes after starting cold. The units are described as extremely flexible, with one model handling any load from 500 to 15,000 lb per hour.

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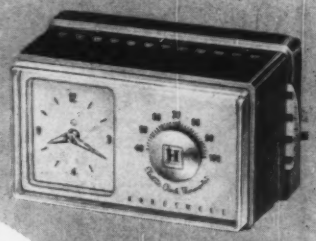

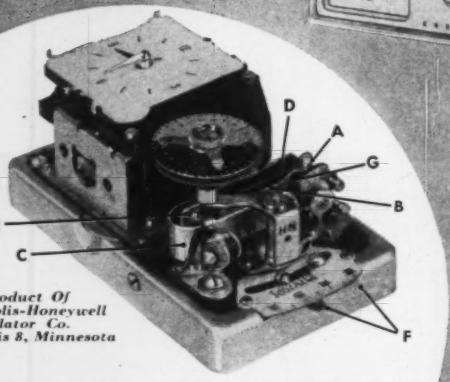


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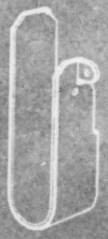
MINNEAPOLIS **Honeywell**

**Clock Thermostat**



This newly designed Electric Clock Thermostat, No. T852A, gives 'round the clock comfort while it adds a touch of elegance to your home. It turns down the heat—automatically—when you go to bed and turns up the heat—automatically—while you're still asleep. Reduces fuel bills, too. The faithful heart of this precision instrument is, of course, Chace Thermostatic Bimetal.

Here's how it works: when the room temperature drops, the contacts (A) on the spring-mounted arm (B) are closed by the deflection of the U-shaped bimetal element (C). This turns on the burner while it also passes current through the heater element (D). After a proper "On" period, the heater warms the bimetal element, causing it to deflect so as to break the circuit, thus providing the short, frequent burner operations necessary for accurate temperature control. For day-night temperature setting, the bimetal element is pivoted at (E), the tab end being connected by an insulating strip to the intricate linkage of the adjusting levers (F). Thus a downward adjustment shifts the element and contact arm away from the magnet (G). Then the room temperature must drop to cause the bimetal to drop toward the magnet, hence the room will be controlled at a lower temperature. The magnet provides snap-action, reducing arcing.

The clock is geared to a cam under the day-night disc. The ingenious design allows each adjustment lever to operate independently of the other, the cam-follower arm riding the low or high contour of the cam engaging the white or brown adjusting lever, respectively.

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*Thermostatic Bimetal*

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YOUR *New Catalogs* GUIDE

### 55 COAL VALVES

**Stock Equipment Co.**—An 8-page bulletin contains descriptive and dimensional data on a redesigned coal valve featuring self-cleaning racks and pinions, strong steel U-shaped gate and large ball bearing equipped gate supporting rollers. The valve is dust-tight. The gate offers lap closure on four sides and is well suited for applications in chemical processes, cement plants and other industries in addition to power plants.

### 56 PIPE FITTINGS, FLANGES

**Tube Turns Plastics, Inc.**—Unplasticized polyvinyl chloride pipe fittings and flanges are the subject of a new booklet. It discusses industrial applications of PVC piping and gives complete specifications for threaded and socket types of fittings and flanges, in both normal and high impact grades.

### 57 MINIATURE BALL BEARINGS

**Miniature Precision Bearing, Inc.**—A new 24-page, 3-color catalog, illustrated with comprehensive specifications on more than 500 types and sizes of standard miniature ball bearings from $1^1/_2$ mm to $^3/_8$ in. OD, includes material of particular interest to designers of precision mechanisms—applications, lubrication, design variations, special bearings, etc.

### 58 OIL AND GAS BURNERS

**Ray Oil Burner Co.**—An illustrated 16-page catalog gives specifications and capacities of commercial and industrial oil and combination gas-oil burners. It covers fully automatic, semi-automatic, and manually controlled horizontal rotary oil burners, gas burners, and combination gas-oil burners; commercial and domestic pressure-atomizing types for oil, gas, or combination gas-oil; forced draft packaged burners. Tables and other technical data are included to aid in selection.

### 59 MATERIALS HANDLING

**Jeffrey Mfg. Co.**—Catalog No. 860 describes experience covering nearly three-quarters of a century, studying handling and processing problems of industry and designing and manufacturing machinery to meet them. The results of service to many types of industries are embodied in this catalog. Describes full line of conveyors, feeders, gravimetric weighers, crushers, shredders, barrel packers, coolers, dryers, magnetic separators, screens, transmission machinery, elevators, power scoops, electronic controls, bin level indicators, rotary bin check valves, car pullers, chains and sprockets.

### 60 RUST PREVENTION

**Rust-Oleum Corp.**—A general catalog contains 102 color chips showing colors available in primers, short oil type coatings, oil field finishes, restful color group finishes, machinery and implement colors, long oil type coatings, Galvinoleum coatings, heat resistant coatings, chemical resistant coatings, floor and deck coatings.

### 61 SPIRAL-WOUND GASKETS

**Flexitallic Gasket Co.**—A 28-page general Catalog illustrates and describes standard and non-standard flange gaskets, and boiler gaskets. Construction features, gasket design and materials, specifications and characteristics, bolting data, facing dimensions and wall thicknesses of welded and seamless steel pipe are included.

### 62 SPEED REDUCERS

**Western Gear Works**—Bulletin 5402 covers the company's herringbone speed reducers. Dimensional information is tabled and diagrammed, and specifications, ratios and performance data is included.

### 63 COUPLINGS

**Snap-Tite, Inc.**—Four bulletins and various data sheets cover couplings for high pressure systems, gravity flow systems, vacuum systems and hydraulic systems. Cutaway photos, diagrams and flow charts are included in the literature.

### 64 CLUTCHES, BRAKES

**Warner Electric Brake & Clutch Co.**—Bulletin No. 6170 describes a complete line of electric clutches and brakes from 8 in.-lb to 700 ft-lb of torque. Also illustrated is a new line of stationary field clutches and replaceable face brakes utilizing the company's new induced magnetic circuit design

YOUR

## *New Catalogs* GUIDE

### 65 GROOVING TOOL

**Waldes Kohinoor, Inc.**—Catalog No. GT2-53 presents general information, engineering specifications, and manufacturing technical data for the Waldes Truarc grooving tool. The manual is illustrated with a number of tool setups and explains the functioning of the tool, particularly its economic performance on recessing operations. It also includes typical applications, dimensions and conversion tables, and ordering specifications.

### 66 OIL FIELD EQUIPMENT

**Lufkin Foundry & Machine Co.**—Catalog No. 56 lists specifications, descriptions and principal dimensions of conventional beam-type pumping units, air balanced pumping units, hydraulic long stroke units and gas engines for oil field applications.

### 67 TAPERED ROLLER BEARINGS

**Timken Roller Bearing Co.**—An eight-page folder describes the four new tapered roller bearings along with auxiliary parts that have been developed to provide customers with lower cost bearing applications without sacrificing the long life and minimum maintenance expected.

### 68 CAST, FORGED VALVES

**Edward Valves, Inc.**—Condensed catalog 105 contains data on cast and forged steel valves for a variety of applications in boiler rooms, petroleum service, industrial and technological plants. Included are Rockwell-built Mudwonder mudline valves designed primarily for mudlines in oil fields but also suitable for abrasive fluid application in industry.

### 69 FORCED, INDUCED DRAFT FANS

**Green Fuel Economizer Co., Fan Div.**—The company offers three bulletins: (1) covering mechanical forced draft and induced draft fans; (2) diffuser fans; (3) the company's Economizers; (4) Fly ash collectors; (5) Industrial air cleaners.

### 70 CENTRIFUGAL PUMPS

**Pacific Pumps, Inc.**—"The Choice, Design, Characteristics and Maintenance of Centrifugal Pumps" is a reprint in booklet form of three published articles.

### 71 MECHANICAL CONSTRUCTION

**Dravo Corp., Machinery Div.**—"Engineering Constructors," catalog No. 1200, describes the company's mechanical construction services. Prepared as a photographic story, the book shows typical examples of construction projects completed for steel mills, chemical plants, water works and the petroleum industry. Introduction explains how a staff of experienced engineering-construction specialists are equipped to consummate any type of working contract.

### 72 BIN LEVEL CONTROLS

**Bin-Dicator Co.**—Catalog describes and illustrates bin level indicators including new Roto-Bin-Dicator and Bin-Flo aerator units. Dimensional drawings, mounting details, typical applications, wiring diagrams, and list of present users.

### 73 STEAM TURBINES

**Terry Steam Turbine Co.**—Bulletins in looseleaf form which cover a complete description of Terry solid wheel turbines with cross section drawings of typical units for both moderate and high steam pressure conditions: a description of the Terry axial flow impulse, both single stage and multi-stage; Terry gears which are used for speed increasing and speed reducing.

### 74 BALL BEARING SWIVEL JOINTS

**Chiksan Co.**—A new 32-page catalog, G-4, covers the company's line of ball-bearing swivel joints, loading racks, manifolding lines, all-metal marine and barge hose, and flexible aircraft assemblies. Typical industrial applications are illustrated and dimensional and operating data is provided.

### 75 MOTOR SELECTION

**General Electric Co., Motor Dept.**—Bulletin GEA-6200, covering a-c motors of 1 to 30 hp, is designed to answer questions concerning the purchase of motors for machines. Service, stocking, motor enclosures, drive requirements, mounting requirements, application information are illustrated and described.




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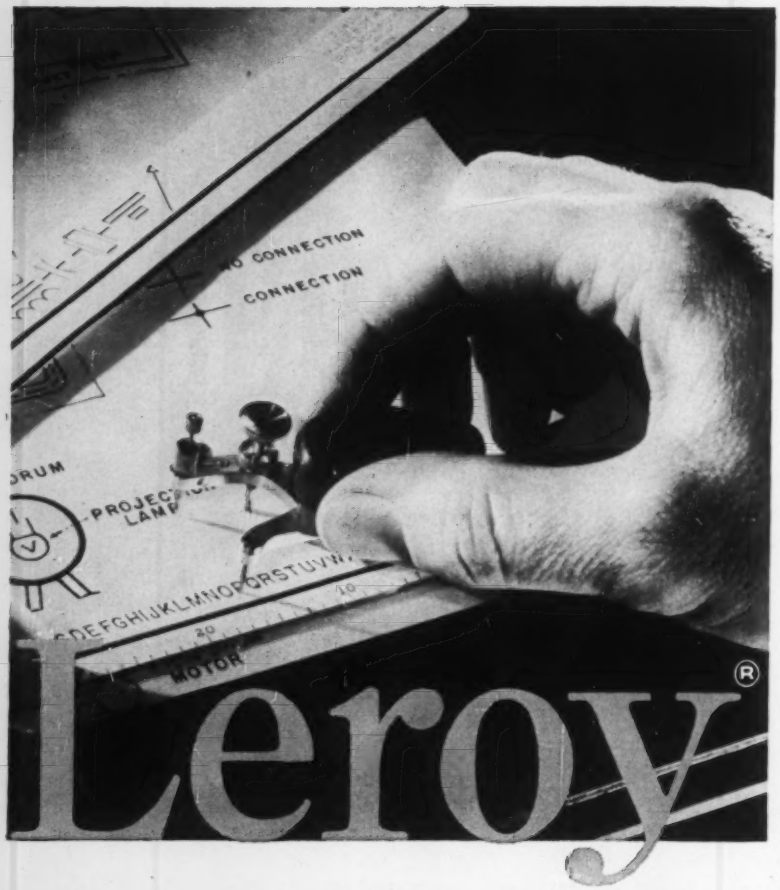


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YOUR *New Catalogs* GUIDE

**76 CARBON-GRAPHITE**

**United States Graphite Co., Div. Wickes Corp.**—Engineering Handbook GT-55 describes basic characteristics, chemical resistivity, mechanical properties, physical properties, size limitations, suggested tolerances, and operating information for Graphitar (carbongraphite). Suggested methods of assembly and typical applications are also shown. Listing of district representatives and other company products included.

**77 LUBRICANT DATA**

**Fiske Bros. Refining Co., Lubriplate Div.**—1956 edition of The Lubriplate Data Book to all who are interested in subject of proper lubrication of all types of machinery. This new Data Book is 8½ × 11 in. in size and contains 36 pages of valuable data pertaining to improvement of machine operation, reduction of power consumption and lowest possible maintenance costs through the use of specialized time tested lubricants.

**78 UNDERGROUND PIPE INSULATION**

**American Gilsonite Co.**—A four-page Bulletin gives tips on the uses and installation of a new insulation for hot underground pipes. It explains how the material protects pipes against corrosion caused by acids and alkaline ground waters, and against bacterial action, roots and electrolysis.

**79 SPECIAL PURPOSE RUBBER**

**B. F. Goodrich Chemical Co.**—A 20-page booklet gives specifications and application data and shows photos of uses of Hycar American rubber in various forms throughout industry. This special purpose material is said to resist oil and solvents, abrasion, aging and high temperatures.

**80 STAMPED GEARS**

**Winzeler Mfg. & Tool Co.**—A 4-page illustrated bulletin describes stamped gears: spur, crown, pinion, spur and pinion clusters, laminated and special types. Gear data and tables are included. Also available is a 4-page stock gear die list including 8-96 diametral pitch spurs, 14½ and 20 deg pressure angle; crown gears, 24-64 diametral pitch.

**81 BALL BEARINGS**

**Federal Ball Bearings Co.**—Catalog D-1 contains 24 pages of dimensional tables for selection of ball bearings according to size, and assists in the identification of ball bearings for which a replacement is required. Both metric and inch measurements are shown. Catalog also includes interchange and conversion tables.

**82 GENERAL BULLETIN**

**W. C. Dillon & Co.**—A 6-page folder illustrates and describes overload switches, universal testers, mechanical force gages, dynamometers, thermometers and weight indicators.

**83 MARKING MACHINES**

**Jas. H. Matthews & Co.**—A 24-page catalog illustrates and describes bench-mounted, hand-operated, pneumatic, and hydro-pneumatic marking machines for metal products. Specifications are given, and accessories are listed.

**84 FORGINGS**

**Drop Forging Assn.**—A six-page booklet, entitled "Management Guide to the Use of Forgings," states the advantages forgings offer to the designer, metallurgist, purchasing agent and executives.

**85 INTERFEROMETER**

**Link Aviation, Inc.**—A leaflet is available describing the Link Fringecount micrometer which is a measuring device using the light interference principle. Measurements up to two inches are possible, with accuracy claimed of one millionth of an inch. Gage blocks, plug gages, and ball and roller bearings measured.

**86 STEAM, AIR TRAPS**

**C. E. Squires Co.**—A four-page bulletin covers steam and air traps for pressures to 600 psig. Cutaway photos show features and flow capacities are tabled. Accessory equipment is listed.

YOUR

## *New Catalogs* GUIDE

**87 FLEXIBLE METAL HOSE**

**Flexonics Corp.**—A 12-page catalog covers line of Flexon flexible metal hose. The three main types of flexible metal hose and their specifications are given, typical applications are told, couplings available described, and a chart on how to select metal hose is included.

**88 ELECTRONIC CONTROLS**

**Dynamatic Div., Eaton Mfg. Co.**—Bulletin EC1 covers the construction, performance and maintenance of electronic controls used on the firm's eddy-current adjustable speed drives and other equipment.

**89 CHROMIUM PRODUCTS**

**Van der Horst Corp.**—A bulletin covers, in question and answer style, the properties and application of the firm's Porus-Krome, a pure hard chromium applied to cylinder bores and other bearing surfaces by a process which produces pores to hold lubricating oil.

**90 PIPE FITTINGS**

**Ladish Co.**—A 304-page, tabindexed catalog details specification on complete line of controlled quality butt welding fittings, forged ASA, large diameter and TEMA flanges and forged screwed and socket welding fittings. A 56-page technical data section features latest provisions of applicable piping codes and standards to assist in solving piping problems.

**91 DRAFT INDUCERS**

**L. J. Wing Mfg. Co.**—A 16-page booklet covers draft inducers for heating boilers and for power plants. The units are of packaged design, factory assembled, horizontal or vertical discharge with gas inlets on either side or top or bottom. Fan bearings are air cooled and pre-lubricated. Also included are illustrations of applications of the company's units and a discussion of the advantages of correct draft in industry.

**92 CHUCKING MACHINES**

**National Acme Co.**—Bulletin CM-51A illustrates and describes 4, 6 and 8 spindle chucking machines in capacities ranging from 5¼ to 12 in. Construction features are shown in cutaway drawings. Specifications and dimensions are tabled.

**93 RECORDER**

**Leeds & Northrup**—A 44-page technical publication illustrates and describes recorders which provide more than 2300 variations of measuring circuits, each developed for applications to certain types of measuring problems. The variety of measuring circuits are described, along with the unit's balancing system, and types of instruments available.

**94 SPECIAL ALLOY STEEL**

**Jones & Laughlin Steel Corp.**—A 40-page booklet contains case histories of Jalloy heat treated special alloy steel plate in such uses as trailer bodies, ore chutes, shovels and dipper sticks, picking tables, structural members, hammers, grader blades, dump truck, bottom line plates.

**95 AUTOMATIC BOILERS**

**Orr & Sembower, Inc.**—Bulletin 1220 covers Powermaster packaged automatic boilers for light oil, heavy oil, gas or combination gas-oil firing in sizes to 500 hp, pressures to 250 psi. The units are completely factory assembled, and have fully automatic operating and safety controls.

**96 WATER HEATERS**

**American Dist. Steam Div., Adsco Industries, Inc.**—Bulletin No. 54-78A illustrates and describes instantaneous water heaters. Included are domestic water heaters, booster heaters, pool heaters and condensate coolers of various types.

**97 ROLLER CHAIN**

**Atlas Chain & Mfg. Co.**—Catalog ARC-52 on roller chain covers construction, features, selection and design, chain length computation, length conversion table, chain drive layout, horsepower ratings, installation and maintenance, lubrication and list prices and specifications.


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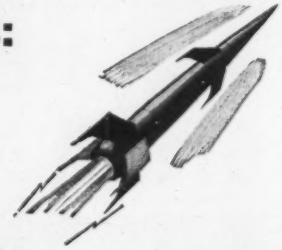

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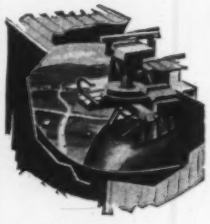

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YOUR *New Catalogs* GUIDE

**98 RUBBER DATA**

**Acushnet Process Co.**—A 32-page catalog covers the company's manufacturing and testing facilities and applications for molded products of various synthetic rubbers. Included are properties tables of rubbers and compounds, data on methods of molding and a glossary of rubber terms.

**99 FIRED INDIRECT HEATERS**

**Brown Fintube Co.**—Bulletin No. 551 covers the applications, advantages and types of fired indirect heaters for air, special atmospheres, corrosive and non-corrosive gases, thermal chemicals, circulating oils, asphalt, and for super heating vapors.

**100 DRAWING MATERIALS**

**Eberhard Faber Pencil Co.**—A new catalog in full color, illustrates line of drawing materials for artists, engineers, designers, draftsmen and architects. It includes a wide variety of drawing and colored pencils, marking instruments, pastels, and erasers.

**101 AUTOMATIC VALVES**

**Golden-Anderson Valve Specialty Co.**—A catalog of technical bulletins describes various types of automatic cushioned water and steam valves including cushioned swing check valves, surge relief valves, water pressure reducing valves, altitude control valves, float valves, strainers, solenoid operated valves, flowtrol valves, electric check valves, non-return valves, triple acting non-return valves, hydraulic cushioned check valves, engine stop valves. Each bulletin is fully illustrated with diagrams, tables, and parts list, specification.

**102 GRAPHITE-CARBONS**

**Morganite, Inc.**—A catalog includes a general compilation of the types of graphite-carbons manufactured by the firm to customer specifications. It includes do's and don't's for designers, physical characteristics of materials and specific aids on such applications as bearings, piston rings and vanes.

**103 ALUMINUM HEAT EXCHANGER TUBES**

**Aluminum Co. of America**—Illustrated catalog contains relevant data on Alcoa aluminum heat exchanger tubes. Covers advantages, fabrication, application in petroleum and petrochemical industries, chemical, steam, atmospheric, air and gas. Also use of aluminum alloys, fluid flow characteristics, heat transfer characteristics, specifications and data with tables.

**104 DRYERS, COOKERS**

**Standard Steel Corp.**—A 12-page catalog, No. 561, illustrates and describes rotary dryers and cookers, including direct fired, indirect fired, steam tube and steam jacketed. Pilot plant operation is also described.

**105 UTILITY BLOWERS**

**Peerless Electric Co.**—Bulletins SDA-160 and SDA-200 illustrate and describe the firm's line of fans and blowers for industrial, commercial and residential use. Dimensional data is tabled and diagrammed. Engineering information and specifications are included.

**106 NEEDLE THRUST BEARINGS**

**Torrington Co.**—A four-page folder describes a new needle thrust bearing. Incorporating data on the bearing's design, installation, lubrication and load capacity, the folder also gives dimensions and other detailed information about each bearing available. Typical needle thrust bearing applications are illustrated and described.

**107 CONTROL VALVES**

**Oilgear Co.**—Bulletins 80200 and 80300, 24 pages, cover construction, principle of operation and installation dimensions of two-, three- and four-way directional control valves for fluid power systems up to 5000 psi. Eight sizes from 1/2 to 3 in., each with manual, mechanical, hydraulic, electric and electric pilot operators are listed, along with two-way valves with standard normally open or normally closed plungers and over sixty special plungers and three- and four-way valves with seven standard plungers and over one-hundred special plungers. More than 300 special straight, angle or combination pipe tap or welded pipe steel flanges are listed.

YOUR *New Catalogs* GUIDE

### 108 FEEDWATER HEATERS

**Alco Products, Inc.**—A 16-page bulletin covers feedwater heaters for central stations and power plants. The firm's facilities for producing the equipment is illustrated and describ l, and design and engineering principles are discussed. Application photos are included.

### 109 REFERENCE JUNCTION

**Pace Engineering Co.**—A data sheet describes a thermostatically controlled temperature reference for multi-channel thermocouple systems. Specifications include temperature stability and uniformity among thermocouple reference junctions as well as descriptions of special circuit features and thermocouple combinations. A complete control system for oscillographic recording is also described.

### 110 FLOW TRANSMITTER

**Foxboro Co.**—Bulletin 13-11 describes advanced design Type 13A d/p cell transmitter designed for all types of flow and liquid level measurements. Bulletin 20-14 explains the firm's magnetic flow meter for difficult fluids, and Bulletin 13-23 covers a new linear, pneumatic flow integrator.

### 111 VIBRATING FEEDERS

**Carrier Conveyor Corp.**—Natural frequency mechanical vibrating feeders are illustrated and described in Bulletin No. 1001. No complicated electrical equipment is used in these feeders which come in standard widths to 72 in. and lengths to 12 ft. Special high temperature models for 1800 F material are available. All models are available with fixed or variable feed rate drives.

### 112 HARD CARBIDES

**Kennametal, Inc.**—A 44-page booklet describes basic design principles for use of hard carbides; methods of forming; methods of fastening carbides mechanically; and a general treatise of Kennametal and suggested fields of application.

### 113 PUNCH PRESSES

**Kenco Mfg. Co.**—New individual catalog sheets cover 14 models of punch presses, ranging in size from 2 to 15 tons, also 2 models of Electro-Safe in 15-ton size.

### 114 MOLY IRON CASTINGS

**Climax Molybdenum Co.**—Bulletin No. 1 explains that molybdenum is selected as an alloying element on the basis of performance and cost in typical iron castings. Bulletin No. 2 relates how the adaptability of molybdenum to foundry operations can benefit the user and the foundry.

### 115 GEARMOTORS, MOTOGEARS

**Link-Belt Co.**—A new line of gearmotors and Motogears is described in 28-page Book No. 2447, which includes complete selection data together with features of construction, load classifications, dimension tables, overhung load ratings and mounting assemblies. Both designs are in keeping with new NEMA motor sizes.

### 116 BOILERS, GENERATORS

**Erie City Iron Works**—A 16-page condensed catalog, No. SB-50 offers a line of boilers and allied equipment, including custom engineered and standard water and fire tube steam generators. Underfeed, spreader, traveling grate stokers and pulverizers are cross sectioned. Waste heat boilers, water walls, superheaters, economizers and air heaters are also shown.

### 117 ROLLER CHAIN

**Acme Chain Corp.**—An illustrated 76-page catalog covers precision roller chain and sprockets. Horsepower charts and standards to assist in design and application problems are presented.

### 118 BASE, SURFACE PLATES

**Lake Shore, Inc., Engineering Div.**—An 8-page catalog offers descriptions of base plates, surface plates, engine jack, stands and dynamometer bases. Installations in laboratories of automotive manufacturers are pictured.

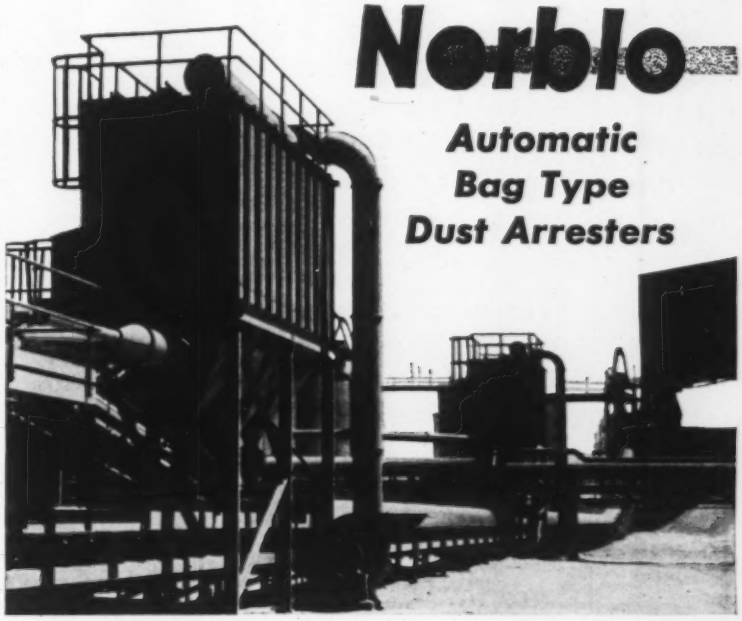
### 119 FIBERGLAS PANELS

**Resolite Corp.**—A 12-page brochure illustrates methods of application of standard and fire retardant Fire-Snuf Fiberglas panels for plant


# Full dust collecting capacity always available from

# Norblo

## Automatic Bag Type Dust Arresters

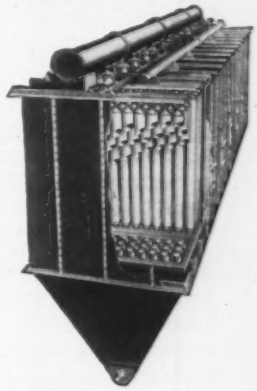


Norblo Dust Arresters at California Cement Corp. plant at Mojave, Cal.

Twenty-four hours a day is a gruelling grind, but Norblo equipment takes it. What's important to plant owners and operating staff is that full dust collecting efficiency holds level during the day and night punishment.

Norblo installations include a group of basic compartment units, each housing 78 cylindrical bags. Variable cyclic cleaning involves one compartment at a time, and that for only a few seconds. Engineered to the needs of each installation, there's ample capacity without waste, but without undue strain on the equipment. Easy maintenance is provided for.

Users of Norblo Equipment in cement plants, industrial plants of many types, and mining and smelting agree that complete satisfaction is assured when you install Norblo. Write for information—state your dust collection problem.



**Norblo also builds centrifugal and hydraulic dust collectors, exhaust fans, cement air cooling systems, and portable type dust collectors.**

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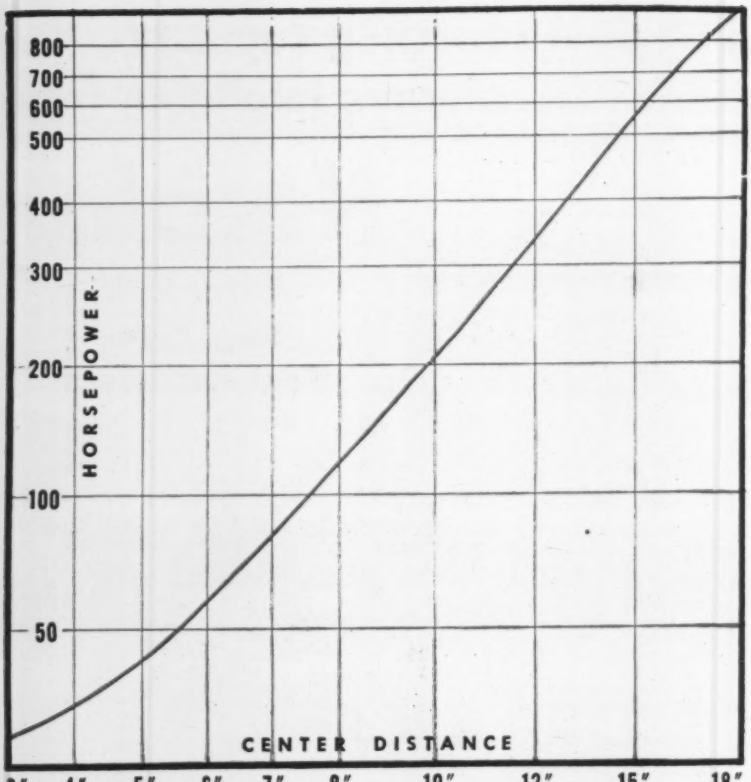


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... because we think the load-carrying capacity of Cone-Drive speed reducers is pretty impressive all by itself. Then, we've also got a lot of friends in the worm gear speed reducer business. And they make pretty fair reducers themselves.

Two things are responsible for the high capacity of Cone-Drive speed reducers. First, we use extra-heavy gears mounted on oversize taper roller bearings in reinforced, heavy housings. Extra "beef' alone accounts for part of our capacity.

Even more important, however, is the Cone-Drive double-enveloping worm gear design. Here, we literally wrap worm and gear around each other to put ⅛ of all teeth in continuous full-depth contact. This results in spreading tooth contact ovet a greater area, reducing pressure on individual teeth, increasing load capacity and life of the gearing.

Ask for Bulletin 600C without obligation.

CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
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## YOUR New Catalogs GUIDE

daylighting through roof and wall, in most standard industrial building construction assemblies. Included are details of end lap and side lap fastenings, and methods for shatter-proof sash glazing.

### 120 CONDENSERS

**Maryland Shipbuilding & Drydock Co., Industrial Products Div.**—Bulletin G100 describes steam surface condensers and related heat transfer products for power process industry applications. Views of the company's facilities and its products are included.

### 121 SPEED REDUCERS

**Jones Machinery Div., Hewitt-Robins, Inc.**—Engineering Catalog 100 covers herringbone speed reducers rated in accordance with AGMA standard practice. Sections of the 160-page booklet include reducer types and styles—bed plates; reducer design—production; selection information; quick selection tables; selection examples; ratings and dimensions.

### 122 PLATE FORM MOUNTINGS

**Lord Mfg. Co.**—Bulletin No. 702 contains engineering data, performance curves, specification tables, details on the design and use of plate form and multiplane mountings to control steady state vibration plus occasional shock where excellent isolation characteristics and moderate restraint are needed. Load capacities range from ½ to 310 lb per mounting.

### 123 ALUMINUM ALLOYS

**Kaiser Aluminum**—A 24-page booklet offers information on mill products and services. Data is given on aluminum alloys, forms, mechanical and physical properties, applications, fabricating and finishing techniques and availability. Products include sheet, plate, foil, circles, pig, alloy ingot, rod, bar, wire, electrical conductors, forgings, extrusions, extrusion billets, roofing, siding.

### 124 DIAPHRAGM CONTROL VALVES

**Leslie Co.**—Bulletin 5304 describes diaphragm control valves, single seated, for steam, liquid, air or gas with primary service ratings to 2500 psi, 1000 F. They are available in unbalanced or fully balanced types ½ to 10 in. in cast bronze, cast iron and cast alloy steels.

### 125 TORQUE MANUAL

**P. A. Sturtevant Co.**—A 28-page torque manual illustrates application ideas, tabulates torque and tension relationships for both mild steel and high tensile steel bolts and shows screw torsional strength recommendations. Included are illustrations of adaptor and attachment ideas and formulas for using these correctly with torque wrenches.

### 126 FLEXIBLE COUPLINGS

**American Flexible Coupling Div., Zurn Industries, Inc.**—A 12-page bulletin gives selection and engineering data on a newly-designed line of standard couplings having ±1½ deg angular misalignment capacity per gear engagement. Similar data is included on self-lubricating center member couplings.

### 127 WATER SOFTENER

**Cochrane Corp.**—A bulletin covers the firm's hot lime-zeolite softeners. Methods of operation, expected results, chemical savings and simplicity of operation are described in the bulletin, designated Publication 4801-A.

### 128 BI-COLOR GAGE

**Diamond Power Specialty Corp.**—Bulletin 1174 describes a new multi-port bi-color gage, developed to eliminate common gage troubles encountered in medium and high pressure ranges. The principle of dividing the vision slot into a series of individual, round ports is said to offer the solution to a number of problems that are intensified as pressure and temperature increase.

### 129 PACKAGED STEAM GENERATORS

**Union Iron Works**—A 16-page bulletin, MH 3-54, describes Union Type MH packaged water tube steam generators equipped for oil or gas firing or both, with automatic, semi-automatic or manual combustion controls. Included are cutaway illustrations, tube arrangement layouts, photo-sequence story of actual shop assembly and dimension tables for 13 standard sizes from 10,000 to 40,000 lb of steam per hour.

YOUR

## *New Catalogs* GUIDE

### 130 DIAPHRAGM VALVES

**Grinnell Co.**—An 8-page catalog describes diaphragm valves offering streamlined fluid passage, flow control, leak-tight closure. Isolation of working parts from fluid stream is said to prevent product contamination and corrosion of operating mechanism. Flexibility of assembly and wide choice of materials for bodies, body linings and diaphragms are described.

### 131 INVESTMENT CASTINGS

**Haynes Stellite Co.**—A 40-page booklet shows typical physical, mechanical and chemical properties of 26 investment-casting alloys, along with design data and hints on solving design, production and metallurgical problems.

### 132 REFRIGERATION

**Frick Co.**—Bulletin 100-G describes Eclipse compressors said to be now furnished in types for handling any refrigeration at any temperature or load. They are built with 2, 3, 4, 6 or 9 cylinders with speeds up to 1200 rpm.

### 133 STEEL SMOKE STACKS

**L. O. Koven & Brother, Inc.**—A 4-page bulletin illustrates and describes guyed or self-supporting steel smoke stacks of riveted or welded construction. Sizes and capacities are tabled and formulas for figuring anchor bolts self-supporting and guy wire for guyed stacks are included.

### 134 OIL HYDRAULIC POWER EQUIPMENT

**Vickers Inc.**—Catalogs 5002B and M5101A contain general design information and specifications of a line of hydraulic pumps, valves, controls and transmissions for hydraulic power systems for industrial machinery and mobile equipment.

### 135 INDUSTRIAL FILTERS

**R. P. Adams Co., Inc.**—A 10-page bulletin, No. 651, features filters with three-color sectional views, installation drawings, dimension charts, and four-color operational diagrams. Case histories are cited. Other equipment is also shown.

### 136 RUBBERIZED ABRASIVES

**Cratex Mfg. Co.**—The application, adaptability and versatility of rubberized abrasives especially designed for burring, smoothing and polishing operations are set forth in catalog No. 53. Available in wheels, blocks, sticks, cones, and points for machine or hand operations in all industries, the products, uses and grit types are fully presented and illustrated.

### 137 ROOF VENTILATOR

**New York Blower Co.**—A centrifugal roof ventilator aerodynamically designed to exhaust against high resistance and offering flexibility, space-saving and economy is illustrated and described in 4-page Bulletin 565. Capacities and dimensions are given, together with description of propeller-type roof ventilators for use at lower resistances.

### 138 PILLOW BLOCKS

**W. A. Jones Foundry & Machine Co., Hewitt-Robins, Inc.**—Catalog 500 illustrates and describes Timken-bearing-equipped heavy-duty pillow blocks. Included are sections on types of units; selection data on pillow blocks, cylindrical units, spherical units, protected screw take-ups; dimensions; installation instructions; lubrication nformation; parts lists; application photographs.

### 139 MOTOR SPRING

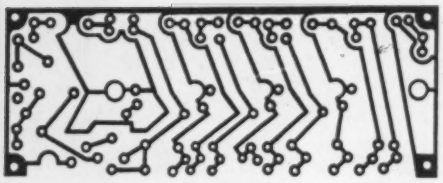
**Hunter Spring Co., Neg'ator Div.**—A 16-page bulletin describes design of constant-force extension and motor springs in six major forms for mechanical loading and power drive applications.

### 140 LIQUID LEVEL GAGES

**Jerguson Gage & Valve Co.**—An 8-page catalog, No. 291, covers remote reading liquid level gages, including a new Truscale with scale that flashes continuously in red when boiler water level gets too high or too low. The catalog is illustrated with photographs and engineering drawings. Gages in four pressure groups from under 900 psi to over 1500 psi are covered.

### 141 DROP FORGED VALVES

**Henry Vogt Machine Co.**—New 32-page supplement No. 1 to Catalog F-9 covers G P gate, globe and angle valves, in sizes 1/2 through 2 in. for



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**COMMUNICATIONS AND NAVIGATION GROUP,** which is responsible for the design of C/N systems in manned aircraft and installation of guidance systems in missiles.

**FIRE CONTROL RADAR GROUP,** which is responsible for the installation and application of the most advanced type of fire control systems in fighter-interceptor aircraft. The work covers the installation of the equipment and associated wiring; continuing liaison with equipment manufacturers; preparation of system analysis and reports; and follow-up of system performance in the field as aircraft become operational.

**INSTRUMENT GROUP,** which is responsible for the design of instrument systems for manned aircraft and the installation of flight test instrumentation for guided missiles.

There are also opportunities for draftsmen with either electrical or mechanical experience.

At Northrop Aircraft you will be with a company that has pioneered for seventeen years in missile research and development. Here you can apply your skill and ability on top level projects such as Northrop's new supersonic trainer airplane, Snark SM-62 intercontinental missile, and constantly new projects. And you'll be located in Northrop's soon to be completed multi-million-dollar engineering and science building, today's finest in comfortable surroundings and newest scientific equipment.

If you qualify for any of these representative positions, we invite you to contact the Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., ORegon 8-9111, Extension 1893, or write to: 1015 East Broadway, Department 4600-D, Hawthorne, California.

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150–800 lb service. Featuring 13 per cent chrome stainless trim with hard facings. All-stainless valves and many trims also available.

## 142 COLD ROLL-FORMING

**Yoder Co.**—An 88-page booklet tells the story of the equipment for and process of cold roll-forming, and uses of its products, their advantages and commercial possibilities. Also listed are auxiliary equipment for curving, coiling, ring-forming, notching, perforating, welding, embossing, automatic cut-off.

## 143 AIR CONDITIONER

**Warren Webster & Co.**—Bulletin B-2020, an 8-page illustrated booklet, describes new air conditioner for year-round heating and cooling. Heating coil connects to existing steam or hot water system. Self-contained, air-cooled, hermetic refrigeration cycle provides cooling and dehumidification. Bulletin gives construction details, unit ratings, dimensions and specifications.

## 144 MINIATURE MECHANICAL CHAIN

**Sierra Engineering Co.**—Catalog describes miniature mechanical chain and sprockets, gives engineering data on chain which operates smoothly around a 7-tooth sprocket with a root diameter of .250 in. and has pitch of .1475 in. The unit is for use where precise motion control is needed in miniature assemblies, especially where motion is to be transferred through several planes simultaneously.

## 145 PROTECTIVE COATINGS

**Koppers Co.**—Eight product bulletins and two technical data sheets are offered. One bulletin is an application manual for Bitumastic coatings. Others deal with specific product information on individual types of coatings and on aluminum paint.

## 146 SPREADER STOKERS

**Hoffman Combustion Engineering Co.**—Catalog No. 55-CAD describes and illustrates features of moving-grate spreader stokers. Catalog 55-PDG describes, illustrates, and supplies additional information on spreader stokers with dumping grates. Capacities from 20,000 to 500,000 lb of steam per hr.

## 147 HYDRAULIC VALVES

**Benjamin Lassman & Son**—A leaflet describes heavy duty industrial hydraulic valves of the directional control, pilot operated check, surge valve and special types. They are built in standard pressures to 3000 psi and special valves are built to 5000 psi.

## 148 ROTATING SERVOMECHANISMS

**Norden-Ketay Corp., Precision Components Div.**—Four-page bulletin No. 376 gives specifications and characteristics of a complete line of two phase servo motors, synchro receivers, synchro control transformers, synchro transmitters, induction motors, tachometer generators, pancake synchros, and resolvers.

## 149 INDUSTRIAL OVENS

**Kirk & Blum Mfg. Co.**—A 36-page catalog shows representative industrial oven installations, with accompanying descriptions including dimensions, heat source, temperature range and loading methods. Included are batch, continuous conveyor, gas, steam, electric ovens, dryers and permanizers for rock wool, paper products, motor stators, automative accessories, metal furniture, plastisol research and laboratories.

## 150 STEEL TUBULAR HEATERS

**Mammoth Furnace Co.**—Literature describes direct-fired space heaters in capacities from 300,000 to 2,000,000 Btu for commercial and industrial space heating requirements, and oil, gas, stoker and hand-fired vertical steel tubular heaters in capacities from 175,000 to 2,379,000 Btu for churches, schools, factories, auditoriums, commercial buildings.

## 151 DUST FILTERS

**Koppers Company, Inc., Metal Products Div.**—A 4-page folder illustrates and describes the compact Model D dust filter. An 8-page brochure covers the Series 12 filter. Both pieces discuss principle of automatic reverse-air jet filter clearing and give design features and dimensions.

YOUR *New Catalogs* GUIDE

**152** METERS, CONTROLS

**Bailey Meter Co.**—More than 100 measuring, transmitting, receiving, recording, and indicating instruments and control components for power and process applications are described in an 8-page bulletin, G15-1. Included are references for each product and 24 instrument and control applications. Addresses and phone numbers of all district offices also listed.

**153** SPEED REDUCERS

**Falk Corp.**—Report 550307 shows how the owners of a 6-kiln aggregate plant were able to stabilize kiln production through the use of modern speed reducers and torsionally resilient shaft couplings.

**154** SINGLE-PASS TAPS

**Horspool & Romine Mfg. Co., Inc.**—A 4-page catalog describes Acme taps with built-in lead screw action to provide full tapping with a single tool in one operation. Included is a specification-dimension table on standard taps in diameters from 3/8 to 2 1/2 in. all standard thread pitches.

**155** TORQUE CONTROL

**Ingersoll-Rand Co.**—Form 5170 describes two new torsion bar torque control Impactools designed for running nuts to prescribed torques. When desired torque is reached, the tools shut off automatically. Two sizes are available, the 5040T for torques up to 90 ft-lb, and the 5340T for torques up to 550 ft-lb. The tools may be quickly set to prescribed torques with easy-to-use jigs.

**156** STAINLESS STEEL CASTINGS

**Crucible Steel Co. of America**—A 20-page booklet illustrates and describes the firm's molding, melting, finishing, inspection and quality control facilities for stainless steel castings. Miscellaneous data on corrosion and heat resistant castings, composition and properties and typical applications are covered.

**157** LABORATORY PRESSES

**Wabash Metal Products Co.**—A four-page bulletin describes the line of manually operated and powered hydraulic laboratory presses from 3 to 50 tons capacity. Heated platens, sensitive pressure and temperature gages, applications, typical users and construction features are described.

**158** GEAR MOTORS

**Sterling Electric Motors, Inc.**—A 12-page colored bulletin described Slo-Speed gear motors, separate motor speed reducers, and multi-mount speed reducers. Description of all products is given along with a technical discussion of engineering features. Bulletin includes technical information on how to select gear motors and speed reducers.

**159** HYDRAULIC OIL

**Shell Oil Co.**—A folder announces Irus Fluid 902, described as the first lubricating oil-base fire-resistant hydraulic fluid. Suggested applications are covered.

**160** MOTION PICTURE CAMERAS

**Wollensak Optical Co.**—A catalog explaining high-speed photography, its application and the results obtainable and a folder describing the operation and uses of the Fastax high-speed motion picture-oscillographic camera are available. These cameras, used in research, design, commercial engineering, are a continuous moving film type with rotating prism positioned between the lens and the sprocket. They are available in 8, 16 and 35 mm in both 100 and 400 ft capacity.

**161** VERTICAL TURBINE PUMPS

**Layne & Bowler, Inc.**—A comprehensive book explains vertical turbine pumps. Included in the 72-page hard-bound work are graphic tables, photographs, drawings and charts.

**162** ECONOMY BOILER

**Francis Steam Generator Co.**—A 4-page bulletin illustrates and describes features of an automatic water-tube boiler with fast recovery for such applications as dry cleaners, laundries, bakeries, canneries, milk product plants, dairies, wineries, bottling plants, food processors, tire retreaders, feed mills, institutions. Diagrams show a dual circulation system and a preheated feed-water system.


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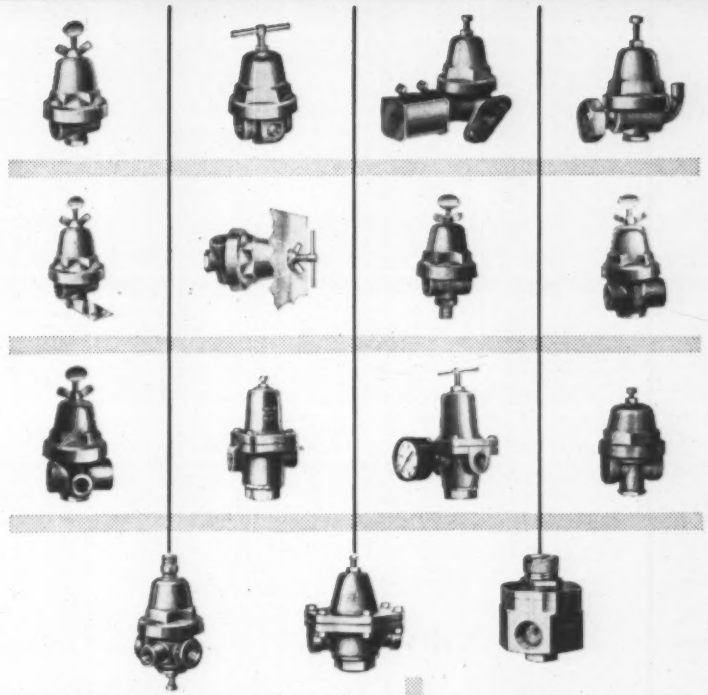

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YOUR *New Catalogs* GUIDE

**163 GLASS-BONDED MICA**

**Mycalex Corp. of America**—A revised engineering data file, contain technical information, design considerations and suggested applications of the company's Supramica ceramoplastic and Mycalex glass-bonded mica products. Charts of electrical and thermal characteristics and tabular data on the physical properties of the materials are included.

**164 BRONZE SLEEVE BEARINGS**

**Bunting Brass & Bronze Co.**—Catalog 52 lists standard stock industrial cast bronze bearings, bars, electric motor bearings. Catalog P56 covers standard stock sizes of sintered powdered bronze oil filled plain, flanged, thrust bearings and bars.

**165 FLUID COUPLINGS**

**Twin Disc Clutch Co.**—Bulletin No. 144-D gives installation and performance data on fluid couplings. Complete with diagrams and drawings, the bulletin shows the use of the firm's couplings on any type of industrial equipment powered by electric motors or internal combustion engines from ¾ to 850 hp.

**166 RING-LOCKED FASTENERS**

**Rosan, Inc.**—Latest edition of 44-page catalog describes and illustrates patented Rosan locking principle. It shows applications, installation and removal procedures, and furnishes design data and dimensions necessary to select an use ring-locked inserts, studs and other threaded fasteners.

**167 PLASTIC RESINS**

**E. I. duPont de Nemours & Co.**—Catalog A-2463 illustrates and describes characteristics, forming and working techniques and end-use applications of Teflon tetrafluoroethylene resin, Zytel nylon resin, Alathon polyethylene resin and Lucite acrylic resin. Detailed properties charts are listed.

**168 DRAFTING DESK**

**General Fireproofing Co.**—A folder illustrates and describes a drafting desk which has a belt positioning control and incorporates a reference area and storage space in one compact unit.

**169 THERMOSTATIC BIMETAL**

**W. M. Chace Co.**—A 44-page illustrated booklet describes and explains twenty-six uses of the company's thermostatic bimetal as regulating, controlling or actuating elements in temperature responsive devices. Included are ten pages of engineering data for element design and selection.

**170 VALVE SPECIFICATIONS**

**Cla-Val Co.**—Catalog covers a standard line of ASA 125 and 250-lb class valves of the following types: vacuum relief, pressure relief, pressure reducing, pump control, rate of flow controller, check, remote control valves and controls, float solenoid and altitude. Catalog includes design and material specifications and list prices.

**171 BELT CONVEYOR**

**Stephens-Adamson Mfg. Co.**—Bulletin 1454-A covers such belt conveyor components as head and tail pulley assemblies, holdbacks, drive assemblies, belting, conveyor carriers, return rollers, steel decking and swivelpilers.

**172 SEALS, TUBING**

**Sparta Mfg. Co.**—Form No. 552 gives specifications and properties of custom molded Teflon in thin sections and in such shapes as cup, ball or shaft seals, washers, gaskets and diaphragms. Form No. 564 gives properties and characteristics of Teflon flexible thin-walled and spaghetti tubing.

**173 LIQUID COOLED COUPLINGS**

**Dynamatic Div., Eaton Mfg. Co.**—Bulletin WC4 gives a detailed discussion of the application, characteristics and construction of liquid cooled couplings. Standard units range from 15 hp at 1700 rpm through 1000 hp at 1100 rpm. Couplings can be provided in other sizes up to 20,000 hp.

**174 BOILER FEED PUMPS**

**Pacific Pumps, Inc.**—Bulletin 122 illustrates and describes boiler feed pumps for high-pressure service. Included are 4-color cutaway photos

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If you had answered our ad four years ago, just think of the potential advancement you would have had with Chemstrand. For Chemstrand has undergone four major expansions in its four short years of operation.

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**The Chemstrand Corporation, Decatur, Alabama**

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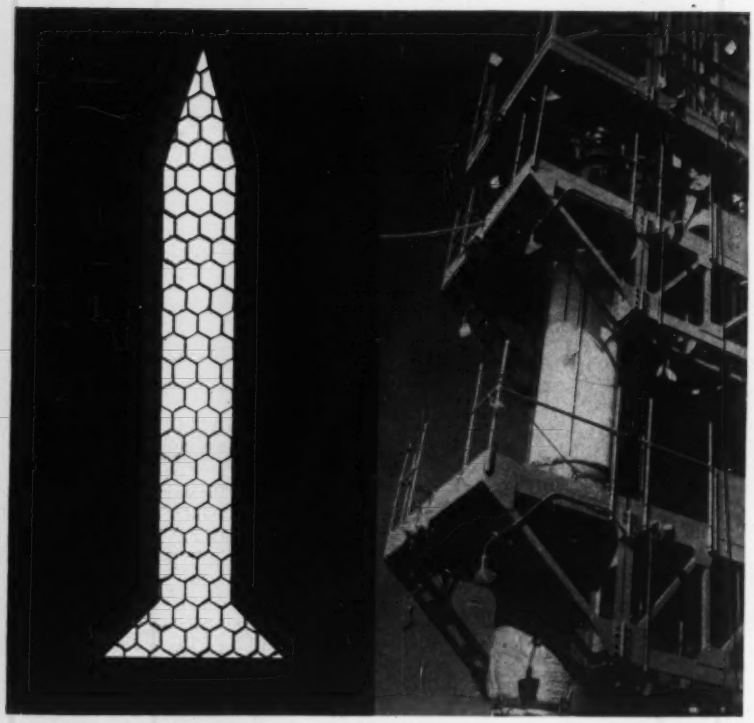

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YOUR *New Catalogs* GUIDE

showing features of the pumps, a performance chart and a discussion of pump design and manufacturing.

### 175 BALL THRUST BEARINGS

**Gwilliam Co.**—Catalog No. 28 describes, illustrates and lists standard sizes of various types of ball thrust bearings, roller thrust bearings, and journal roller bearings.

### 176 OIL, GAS BURNERS

**Petro**—Catalog 3048 gives 20 pages of information on the selection of equipment, engineering and manufacturing factors, design and construction features, types of controls, and types and ratings of Petro packaged units for oil, gas and combination oil-gas burners.

### 177 VIBRATING CONVEYORS

**Carrier Conveyor Corp.**—"Natural-Frequency" vibrating conveyor Bulletin No. 112, 12 pages, describes new application of scientific natural-frequency vibrating principle as applied to Carrier vibrating conveyors with great reduction in power requirements, double capacity, and significant savings in maintenance and down-time costs. Illustrates applications for detergent powder, crushed stone, foundry sand, castings and shakeout, spiral elevating for air cooling and other drying, heating, separating and blending processes; other uses and engineering data.

### 178 BRONZE, IRON VALVES

**Fairbanks Co.**—Catalog 51 provides descriptions and specifications on complete lines of bronze and iron body valves. Bronze valves of all types, including solder and brazed end valves with pressure ratings from 125 to 300 lb steam are covered. Iron body valves of all types, including AWWA and Underwriters Approved, with pressure ratings from 125 to 250 lb steam are listed.

### 179 DRAFTING SYSTEM

**Universal Drafting Machine Corp.**—Literature covers a new portable drating system, consisting of a personal size professional drafting machine, folding drawing board, metal scales, instrument box and travel case, which can be set up on a desk in two minutes. The system, called Desk-Topper, is designed for use at home, in the office or hotel room, or on planes or trains.

### 180 FURNACE CONSTRUCTION

**M. H. Detrick Co.**—A 50-page illustrated booklet, "Heat Enclosure Methods," outlines the development of furnaces and furnace construction. Suspended arch and wall constructions and their applications are shown for boilers, oil heaters, heating and melting furnaces, and other units. Engineering graphs and tables are presented.

### 181 SCREENS, DEWATERIZERS

**Hewitt-Robins, Inc.**—Bulletin 162 illustrates and describes the firm's Eliptex vibrator designed with a three-way motion for sizing and dewatering. Only three vibrator sizes handle the complete range of screen and dewaterizer models, from single deck 3 by 8 ft up to and including 6 by 16 ft and double deck 6 by 24 ft units. All sizes require only a single vibrator mechanism.

### 182 HEATING EQUIPMENT

**Iron Fireman Mfg. Co.**—A 60-page booklet covers engineering data on oil, gas and coal fired heating and power equipment. It is designed, not as a service manual, but to provide architects and engineers with information for better understanding the problems of fuel handling.

### 183 AUTOMTIC CONTROLS

**Mercoid Corp.**—Catalog Number 856, a 52-page reference book for engineers, contains information on automatic controls for pressure, temperature, liquid level, and mechanical movement. Transformer-relays and mercury switches are also listed.

### 184 PACKINGS, OIL SEALS

**International Packings Corp.**—Revised 60-page illustrated catalog and manual 201B covers all types of leather and synthetic rubber packings for hydraulic and pneumatic applications. Information on types, applications and dimensional data of cups, flanges, U and V packings, custom-engineered oil seals, O-rings and other precision molded products.

YOUR

## New Catalogs GUIDE

**185 WELDING ALUMINUM**

**Aluminum Co. of America**—A 176-page, hard cover book gives basic, practical data on the various processes for welding aluminum with special emphasis on the inert gas methods. Included is guidance in selecting the process and the alloy. One chapter is devoted to the performance of welds. The book is profusely illustrated and contains 32 tables.

**186 BALL BEARINGS**

**Fafnir Bearing Co.**—A new 168-page general catalog and engineering manual features dimensions, tolerances, load ratings, suggested applications and typical mountings of the entire Fafnir line of ball bearings and ball bearing power transmission units. Included also is comprehensive engineering data, as applicable to the use of ball bearings.

**187 PIPE COUPLINGS**

**Dresser Mfg. Div.**—A 44-page catalog, 531, contains descriptive material, illustrations and engineering data on flexible couplings for joining pipe from $^{3}/_{8}$ to 72 in. and up in size. Applications are listed and illustrated for waterworks, sewage, oil, industrial, gas, chemical and other fields. Also included is information on pipe fittings, pipe repair clamps and sleeves, service saddles, expansion joints and other products.

**188 STEEL TUBING**

**Bundy Tubing Co.**—A 12-page catalog contains technical information on physical properties, available sizes and method of manufacture of steel tubing. Also included are possible applications and methods of fabricating.

**189 GASKETS, METAL RASCHIG RINGS**

**Metallo Gasket Co.**—Bulletin No. 53 describes metal and metal combined with soft packing for use on high and low pressure service, metal tower packing made as Raschig and Lessig rings. Also included are washers, shims, and metal asbestos valve disks.

**190 GAS AND AIR COMPRESSORS**

**Cooper-Bessemer Corp.**—Bulletin M-70, 40-pages, presents M-line compressors for transmission of gas and air. Installation photos show these units in use on pipelines, in refineries and chemical plants, and uses for air compression in industry. Cross sections and cutaways are included for many of the available types.

**191 VACUUM FOR INDUSTRY**

**Spencer Turbine Co.**—Bulletin No. 155, 12 pages, on vacuum for industry contains complete descriptions of stationary and portable vacuum equipment. New features include a table for the rough calculation of the horsepower required for any specific job, and outline of the latest methods of automatic and hand dumping of refuse, a section on the application of vacuum to machine design, and illustrations of the special vacuum tools used in industry.

**192 HEAT EXCHANGERS**

**Pfaudler Co.**—Manual No. 837 illustrates and describes the firm's new standardized alloy designs of shell and tube equipment for application in the chemical and food industries. This equipment may be installed for any of the following uses: condensers, heat exchangers, heaters, evaporators, coolers and reactors. Selection data, system diagrams, specifications, construction, installation, operation and maintenance information is included.

**193 CENTRIFUGAL PUMPS**

**American-Marsh Pumps, Inc.**—6-page Bulletin 350 describes horizontal split case, single stage, double suction centrifugal pumps. Types HLM and HIM for wide range of capacity and head conditions. Large sectional view explains 18 important features. Specifications, performance data and dimension tables are incluced.

**194 COUNTING DEVICES**

**Veeder-Root, Inc.**—Modern mechanical and electrical counters for all industrial and special counting requirements are briefly described in a four-page condensed general catalog. Also contains information on applications and how-to-order.

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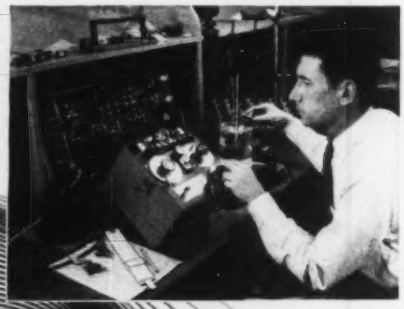

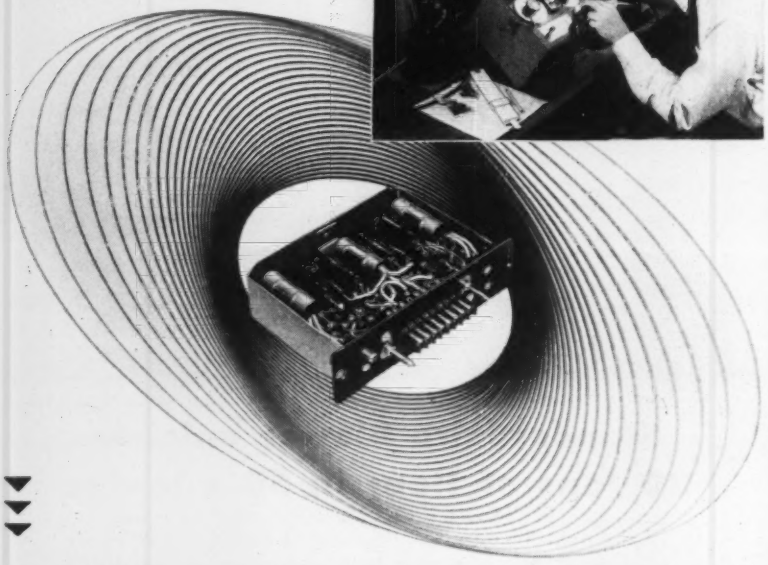

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## YOUR *New Catalogs* GUIDE

**195 LUBRICATION EQUIPMENT**

**Universal Lubricating Systems, Inc.**—A catalog covers air couplers, ball swivels, buttonhead couplers and fittings, drain plugs, flush type fittings, grease fittings, hose and guns, hose adapters, needle type adapters, swivel couplers.

**196 COPPER, COPPER ALLOY**

**American Brass Co.**—A 24-page reference manual contains copper and copper-alloy specifications, including ASTM, ASME, AWS, SAE, AMS, federal, military, Army, Navy, and joint Army-Navy specifications.

**197 CUSTOMIZED MOTORS**

**Jack & Heintz, Inc.**—An eight-page booklet, "Design Your Product To Do a Job—Not to Fit a Motor," covers customized electric motors, and describes the firm's facilities for designing, testing, and producing special electric motors up to and including 2 hp.

**198 TANK, VESSELS**

**Nooter Corp.**—A 48-page Catalog describes facilities, workscope, techniques in custom fabrication of steel and alloy plate for processing industries. Corrosion data tables for various metals are included.

**199 PLUG-IN COMPUTING AMPLIFIERS**

**George A. Philbrick Researches, Inc.**—A 32-page Booklet describes specific uses of plug-in amplifiers for analog computing. Summing, scaling, integration and differentiation plus combinations of these and other linear and non-linear transformations are shown with definite circuits.

**200 BRONZE BEARINGS**

**Johnson Bronze Co.**—A catalog lists and illustrates more than 900 sizes cast bronze bearings, 400 sizes of bronze bars, cored and solid, graphited bronze, powdered bronze in straight, flanged and self-aligning bearings, bearing babbitt.

**201 MULTI-V DRIVES**

**Worthington Corp.**—A 100-page master engineering manual presents a scientific and simplified method for rating V belts. Tables on drive selection contain nearly every possible stock sheave combination. Information on products and range of stock size sheaves with bore limitations is included.

**202 BRONZE VALVES**

**Ohio Brass Co.**—An 88-page bound catalog, No. 57, illustrates, describes and gives specifications on globe and angle valves, gate valves, check valves, radiator valves, balancing valves and special valves made of bronze for industrial and residential use.

**203 AIR COMPRESSORS**

**Gardner-Denver Co.**—An eight-page bulletin illustrates and describes carbon piston horizontal single-stage air compressors for oil-free air in the processing, chemical and plastic industries.

**204 BRASS MILL PRODUCTS**

**Bridgeport Brass Co.**—A 170-page illustrated handbook on brass mill products covers copper-base alloys, strip and sheet, rod and wire, tubing, metalworking, and contains tables, measurements and historical data.

**205 QUICK OPENING DOORS**

**Struthers Wells Corp.**—Bulletin SW-553 covers quick opening doors for processing equipment. Automatic or semi-automatic in operation, the units are available in Ring-lok or Wedg-lok types, designed for vulcanizers, devulcanizers, impregnators, sterilizers, cement block curing vessels, ovens, and creosoting cylinders.

**206 SOLENOID PILOTS**

**Spence Engineering Co.**—A four-page bulletin describes several types of solenoid pilot for use with regulating valves in steam, air, gas and liquid service. Schematic diagrams of typical applications are included.

**207 ALUMINUM CASTINGS**

**Morris Bean & Co.**—A booklet on "The Antioch Process" offers a brief technical description of the mold making process developed by Morris Bean

YOUR

## New Catalogs GUIDE

and used currently in the production of aluminum castings. Loose specification sheets covering applications of the process in aircraft parts, tire molds, electronics fluid flow and miscellaneous castings are available.

### 208 FLOW REGULATOR

**Waterman Engineering Co.**—An illustrated bulletin covers an adjustable flow regulator that is adapted for panel mounting on systems requiring a variable adjustment of the flow rate over a wide operating range.

### 209 BLUEPRINT PENCILS

**American Lead Pencil Co.**—Sampler with free blueprint pencils is offered to engineers, architects and draftsmen. The pencils are especially compounded for outstanding brilliant opaque marking on coarse paper. The company recommends this chemically treated lead for exacting work where a brilliant insoluble and contrasting colored mark is required. It will not be destroyed by sunlight, grease, oil or excessive wetting.

### 210 ALLOY TUBING

**Babcock & Wilcox Co., Tubular Products Div.**—Technical Data Card 163A furnishes technical information on 13 different analyses of tubing steels, including stainless, designed to overcome many problems which arise in high-temperature service. These analyses can also apply in other fields where temperature is not necessarily a determining factor, including chemical, paper, beverage, dairy, and food processing.

### 211 TESTING DEVICES

**Baldwin-Lima-Hamilton Corp.**—Bulletin 4300 lists SR-4 devices and equipment for load, torque and fluid pressure measurement and control. Numerous application photos in all fields are included in this 20-page bulletin.

### 212 SPEED VARIATOR

**Cleveland Worm & Gear Co.**—Bulletin K-200 illustrates and describes a speed variator that provides indefinitely variable output speed over a range up to 9:1 from a constant speed power source. Operating characteristics, diagrams and cutaway drawings are included.

### 213 MICROHONING

**Micromatic Hone Corp.**—A 32-page, two-color illustrated catalog contains description of the cylindrical and flat microhoning process and equipment, specifications and work capacities of horizontal, vertical and microflat machines; automated microhoning; representative range of tools, fixtures and abrasives; short explanation of automatic size control; availability of job service, film and literature aids.

### 214 INSULATION, REFRACTORIES

**Johns-Manville**—A 52-page bulletin illustrates and describes eleven lines of products: insulations and refractory products; Transite® asbestos-cement pipe; packings and gaskets; electrical products; Celite® diatomite filter acids and mineral fillers; Celite® diatomite catalyst carriers and metal Raschig rings; synthetic silicates; friction materials; pipe protection materials; floorings.

### 215 MOTOR CONTROLS

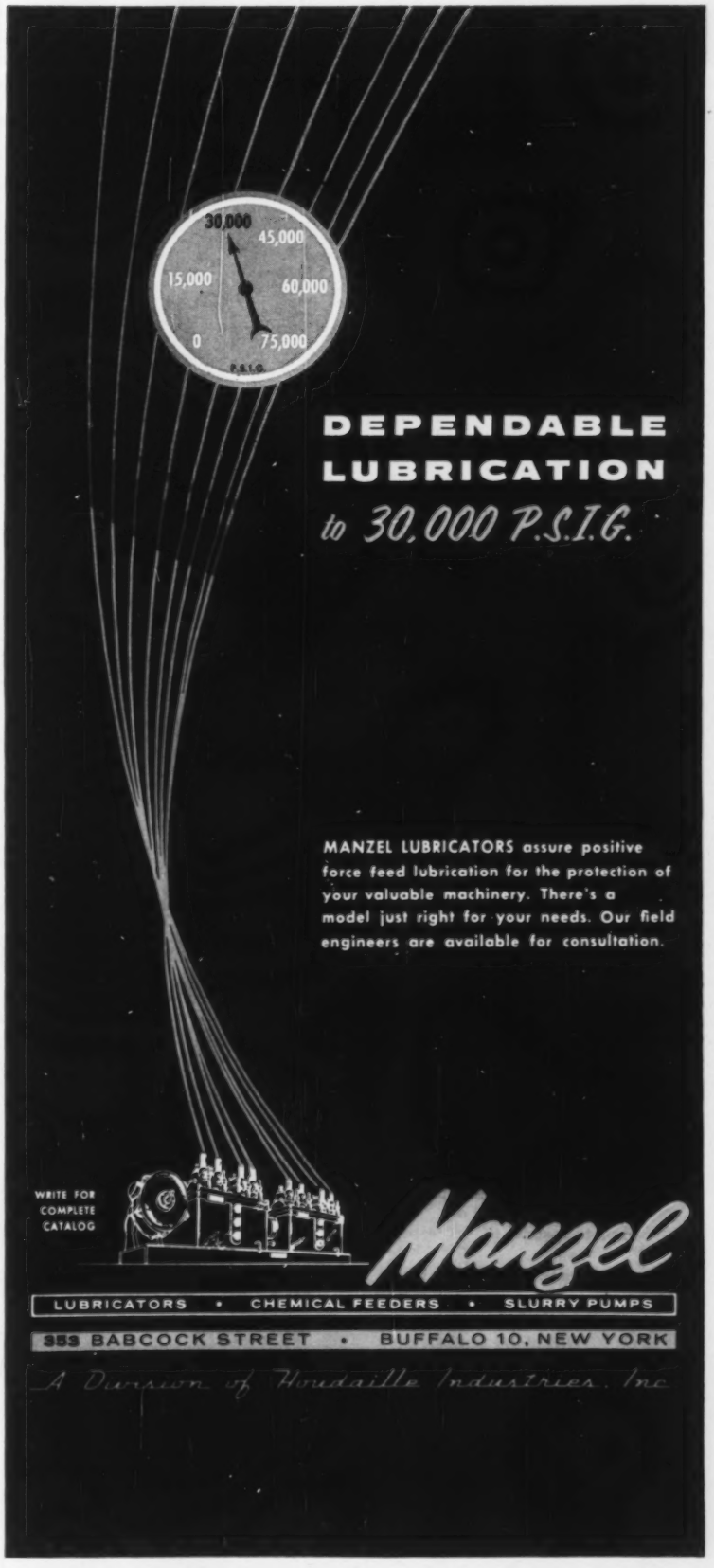
**Clark Controller Co.**—An 84-page catalog covers, manual and magnetic across-the-line starters, motor control centers, reduced voltage and synchronous motor starters, high voltage across-the-line starters, a-c and d-c contacters, a-c and d-c relays. Specifications and dimensions of all units are diagrammed and tabled.

### 216 PLASTIC STEEL

**Devcon Corp.**—A folder illustrates and describes applications for Devcon, a combination of 80 per cent steel and 20 per cent plastic, for use in making jigs, molds, models, fixtures, forming dies, rebuilding machinery and salvaging metal parts. The material, which handles like modeling clay, hardens into a rigid metallic piece in approximately two hours. No heat or pressure is required.

### 217 COMPRESSION PIPE COUPLINGS

**Morris Coupling and Clamp Co.**—A series of bulletins illustrates and gives application data on compression pipe couplings and band type pipe repair clamps. Application photos, diagrams and specification tables are included.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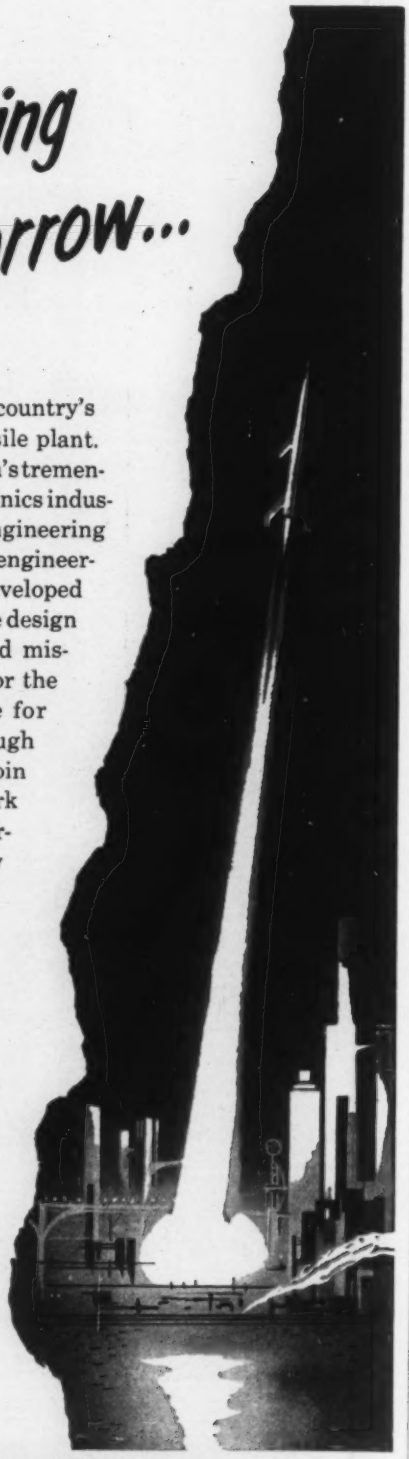

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## YOUR New Catalogs GUIDE

### 218 GAGES AND THERMOMETERS

**Marsh Instrument Co.**—Catalogs No. 76-G and 76-T describe in detail a wide line of industrial gages and thermometers. The catalogs are fully illustrated, including cut-away photographs and enlargements of internal parts. They cover also gage accessories, specifications including line drawings and dimensional tables, and templates covering every size and pattern.

### 219 ROLLER BEARINGS

**Hyatt Bearings Div., General Motors Corp.**—Catalog 150 illustrates and describes solid roller bearings, wound roller solid race and split race bearings, industrial inch bearings and solid roller bearings in separable inner race, separable outer race and nonseparable types.

### 220 STUD WELDING

**Nelson Stud Welding Div., Gregory Industries, Inc.**—A manual covers designing, materials, specifications, dimensions and physical properties of the materials used in the Nelweld method of welding studs.

### 221 DIESEL ENGINES

**Alco Products, Inc.**—A bulletin illustrates and describes Model 251 diesel engines in three sizes, 6, V-12 and V-16, and ratings from 550 to 2400 hp. A cutaway photo shows the operation of the units, and each component is illustrated and described. Dimensions and specifications are given.

### 222 CONVEYOR SYSTEMS

**Fuller Co.**—Bulletin G-3, eight pages, pictures and describes pneumatic conveying systems built by the company for handling dry, pulverized and granular materials. Diagrams showing how systems work are included. Also illustrates and describes rotary compressors and vacuum pumps, inclined-grate coolers and Humboldt preheater for handling dry, granular materials.

### 223 FLEXIBLE, SWIVEL, SWING, AND REVOLVING JOINTS

**Barco Mfg. Co.**—A group of catalogs cover flexible, swivel, swing, and revolving joints for piping and lines conveying steam, oil, air, gasoline, water, chemicals, including corrosive acids and alkalies, and other fluids or gases. Types cover pressures up to 750 psi, steam, and 7500 psi hydraulic. Complete range of sizes. Catalogs No. 215 "Flexible Ball Joints"; No. 265 "Rotary Swivel Joints"; No. 400 "Barco Swing Joints"; No. 300 "Revolving Joints" and No. 269 "High Pressure, Hydraulic Swivel Joints."

### 224 DEAERATORS, VALVES

**American Water Softener Co.**—Booklet 402 illustrates and describes the firm's line of tray type deaerators. Booklet 801 covers hot process softeners, hot Zeolite softeners, deaerating hot process softeners and associated accessories. Bulletin 600 describes the function, operation, design and construction of a balanced piston, single-seated, single control valve for ion exchange cycles.

### 225 ROLL FORMED SHAPES

**Roll Formed Products Co.**—A 26-page catalog covers the production of roll formed shapes. Processes shown include notching, punching and cutting to length of special shapes in one continuous operation. Also included are drawings and dimensions of more than 100 simple and complex shapes.

### 226 ALUMINUM

**Revere Copper & Brass, Inc.**—"Revere Aluminum Products" 36 pages, discusses the advantages of aluminum alloys, the variety of extruded products available, the uses to which seamless drawn tube and pipe can be put, and the uses of sheet, bus bar, and die-pressed forgings. It contains many tables giving both mechanical and physical properties.

### 227 EFFECTS OF CHECK VALVES IN OVERCOMING WATER HAMMER

**Williams Gauge Co.**—The cause, effect, and control of water hammer in piping systems are considered in an 8-page bulletin. After describing water hammer in nontechnical terms, the brochure indicates its potential damage to piping, instruments, and other parts of water systems, and considers methods of controlling it.

YOUR

## New Catalogs GUIDE

### 228 SPREADER STOKER

**Detroit Stoker Co.**—A 16-page catalog describes the company's type C-C continuous ash discharge spreader stoker designed for firing all types and makes of modern boilers from approximately 5000 to 75,000 lb per hr steam capacity. Photographs and diagrams of typical installations are included.

### 229 HYDRAULIC MACHINERY

**Watson-Stillman Press Div., Farrel-Birmingham Co.**—A 24-page bulletin gives information on injection, compression, and transfer molding machines for the plastics industry; extrusion presses for ferrous and nonferrous metals; metalworking equipment; railroad shop equipment; ordnance equipment; standard and special machinery for general industrial applications.

### 230 CONVEYORS, DUST CONTROL

**Dracco Corp.**—Information is provided on a variety of airstream conveyors and dust control systems now in operation for handling many dry, bulk materials. Solution of material waste and air pollution problems by dust control is described.

### 231 RECORDING SYSTEMS

**Sanborn Co.**—Oscillographic recording systems catalog describes eight-, six-, four-, two-, and one-channel models together with interchangeable preamplifiers available for use either in these systems or with other equipment. These preamplifiers include d-c coupling, carrier, a c/d c, servo-monitor, log-audio, low level stabilized d-c a-c wattmeter, input coupling network, rms volt/ammeter and 400 cycle frequency deviation.

### 232 ALUMINUM CASTINGS

**Thompson Products, Inc.**—An 8-page booklet illustrates and describes the company's facilities for making aluminum and magnesium castings for electrical, commercial, automotive and aircraft use. A section of the booklet covers various castings made for each of these industry groups, and another section discusses the firm's engineering, production, machining and quality control.

### 233 OIL FILTERS, STRAINERS, OILING DEVICES

**Wm. W. Nugent & Co., Inc.**—Seven bulletins: No. 6 illustrates and describes Nugent pressure strainers; No. 7 gravity filters; No. 7A pressure filters; No. 8 tanks, pumps, shaft oilers; No. 14 oiling and filtering systems for turbines, paper mills, steel mills, pumps, compressors; No. 15 oiling devices; No. 16 sight feed valves, multiple oilers, flow indicators, sight overflows, and compression union fittings.

### 234 GRATING-FLOORING AND TREADS

**Irving Subway Grating Co., Inc.**—Catalog F-400 contains illustrations, descriptions and engineering data on grating-flooring, treads, and floor armoring (riveted, press-locked, welded types) for industrial and power plants and refinery walkways, stairways, driveways, trucking aisles; ship cat-walks and engine room floors and treads; locomotive, freight and passenger car runways and treads; roadway armoring expansion joints, catch basin covers; bridge decking.

### 235 WELDING

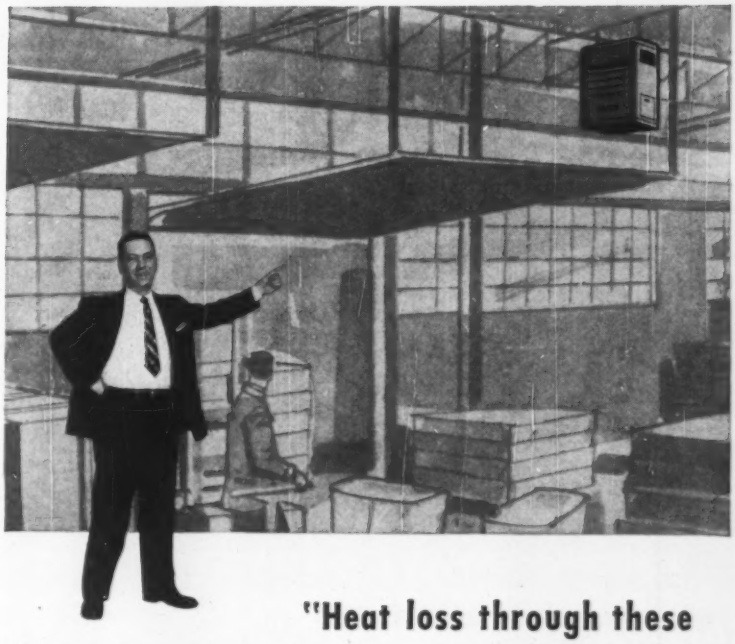
**Lincoln Electric Co.**—"Design Ideas" is a series of pamphlets issued periodically to design engineers, production men, and management executives. Current series outlines fundamentals of how to design with steel, to reduce costs and improve performance, with special charts and checking information.

### 236 VIBRATION ISOLATORS

**Barry Controls, Inc.**—Standard and special mounts for shock, vibration and noise control in airborne, shipboard, and vehicular installations as well as industrial machines are described in 4-page catalog keyed to supply detailed information by reference numbers. Also offers service facilities of representatives for development, test and application of vibration control.

### 237 FIXED TYPE GAGES

**Sheffield Corp.**—Catalog LTG-54, 148 pages, is composed of six sections covering the company's standard fixed type gages. A complete engineering manual for gage designers and users is included in the catalog.

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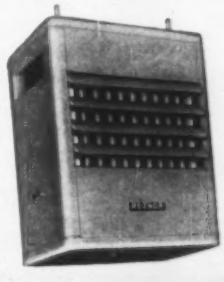

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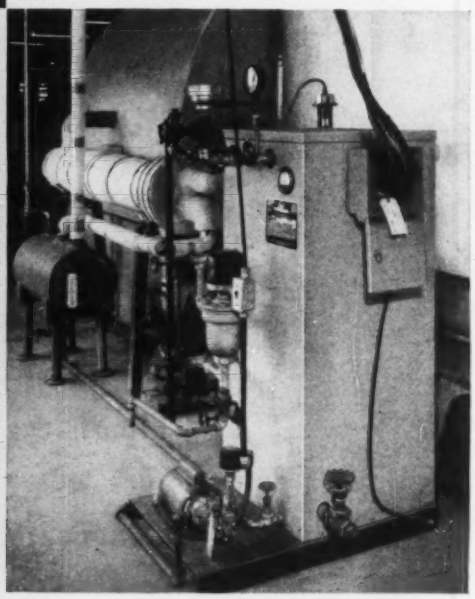


Speedylectric Steam Generator supplying heat to waxer.

Manufacturing huge quantities of waxed paper containers of every size and shape, a nationally-known company needed a reliable source of heat for a production step in which the new containers are deeply impregnated with a special hot wax. Here, as in many manufacturing processes, a Pantex Speedylectric Steam Generator was the answer.

In the impregnation process, accurate control of wax temperature and submersion time is required for dimensional control of the finished product, complete wax penetration and stability of ink colors. The use of a Speedylectric Steam Generator as a heat source not only assures reliable temperature control at modest cost, but eliminates all danger of fire or explosion . . . serious hazards where the plant atmosphere is often full of particles of waxed paper.

Wherever a reliable, convenient, safe source of steam is needed, Speedylectric Steam Generators serve industry. Using a unique electrode method to generate steam, and easily portable, they require no supervision, operate without flame or fumes, and eliminate the risk of fire or explosion.

WRITE TODAY FOR COMPLETE FACTS AND FIGURES

**Speedylectric Steam Jet Cleaners,** too, serve industry in countless ways. High pressure jet of dry steam and solvents quickly removes grease and dirt accumulations from machines and equipment without flooding floors. No need to stop nearby production or move machines outside. Completely safe and portable.

**PANTEX MANUFACTURING CORPORATION**
**Box 660AJ, Pawtucket 11, R. I.**
*Send me facts and figures on:*
☐ Pantex Speedylectric Steam Generators
☐ Pantex Speedylectric Steam-Jet Cleaners

Name and Title .....

Company .....

Address .....


## YOUR New Catalogs GUIDE

### 238 STEAM GENERATORS

**Ames Iron Works, Inc.**—Bulletin AXY-1, describes basic pressure vessel construction, boiler trim, auxiliary equipment and controls furnished on models, A, X, or Y steam generators.

### 239 CENTRIFUGAL PUMPS

**Goulds Pumps, Inc.**—Two bulletins cover pumping applications in industry. Bulletin 721.6 shows 19 sizes single stage double suction centrifugal pumps for capacities up to 6400 gpm, heads up to 400 ft. Bulletin 722.6 shows 5 sizes two-stage centrifugal pumps, capacities up to 1200 gpm, heads up to 1000 ft. Maximum of standardization and interchangeability of parts are described.

### 240 STEEL DOORS

**Kinnear Mfg. Co.**—Bulletin No. 88, 32 pages illustrated, covers steel rolling and other types of Kinnear Doors. One section describes a galvanized-steel sectional overhead-type door that combines durability with operating convenience; facilities for glass light-sections in a door for all types of commercial and industrial service openings are offered. The bulletin gives details, clearance requirements, and available accessories.

### 241 SILICONE PRODUCTS

**Garlock Packing Co.**—An eight-page bulletin covers silicone products for use in diaphragms, gasketing, sheet packing, oil seals, rings, insulation, tape, rod and valve stem packings, and for molded, extruded, die-cut and metal-bonded shapes for various uses. Silicone sponge applications are included.

### 242 CONTROLLED-AIR-DEVICES

**Bellows Co.**—Bulletins BM-25 and ML-3 illustrate and explain air motors and the choice of built-in valves and auxiliary hydraulic controls available for them. Bulletin ML-3 also describes the basic types of complete-work-units, such as power feeds, work feed tables, drilling units. Both booklets contain application photographs.

### 243 FLY ASH INTAKE VALVE

**United Conveyor Corp.**—Four-page bulletin 1-1-55 gives information on various stages of development and design of feeding inlet and intake valve for operation with pneumatic fly ash conveyors. It describes application for manual and automatic operation and lists features of present-day design.

### 244 SEAMLESS METAL HOSE

**Seamlex Co.**—Four-page Bulletin 955 gives essential information on bronze hose from $^1/_{16}$ to 8 in. ID and diesel exhaust hose from 2 to 20 in. ID. Fourteen illustrations show cross sections of hose and fittings. Two tables give technical data. Tabulated service classification serves as aid to writing hose specifications.

### 245 GLASS FIBER INSULATION

**L-O-F Glass Fibers Co.**—Illustrated brochures outline advantages of both Microlite and Superfine glass fiber insulations, low-density resilient insulating materials with high thermal efficiency and sound absorption characteristics. They are described as being resistant to heat, fire, moisture, and corrosion and the company recommends their use in applications where the greatest thermal and acoustical efficiency is desirable in the smallest space. Tables are included on thermal and acoustical performance.

### 246 VIBRATION ISOLATION

**Korfund Co.**—A four-page bulletin gives information on how to write vibration isolation specifications for air conditioning and related equipment. It contains a definitive treatment of the factors involved in the selection of various isolation media commercially available and has a selector chart designed to simplify writing specifications.

### 247 FLEXIBLE COUPLINGS

**American Flexible Coupling Div., Zurn Industries, Inc.**—Twelve-page Form 12 contains case histories on power transmission applications using Amerigear couplings. Included are applications in heavy mill service, high-speed turbines, hydraulic presses, power supplies.

YOUR

## New Catalogs GUIDE

**248 OPTICAL TOOLING**

**Charles Bruning Co.**—A 20-page illustrated booklet, explaining the theory, principles, and practice of new technique of optical tooling. The booklet shows how optical tooling provides tolerances of .003 in. in 100 ft. It is claimed to have easier construction, assembly, inspection, and unsurpassed dimensional control in erecting jigs, fixtures, and assembly structures.

**249 THREAD INSERTS**

**Heli-Coil Corp.**—Catalog on standard line of screw thread inserts designed for protection and repair of tapped threads in all materials is contained in Bulletin 652-A. Covered are design information, drilling and tapping recommendations, and specifications for various classes of fit. Also available is Bulletin 738 which provides similar details on new screw-lock insert which eliminates the need for lock washers, lock nuts, lock wiring.

**250 MATERIALS HANDLING**

**Syntron Co.**—A condensed catalog, No. 564 contains 50 pages of technical data, brief description and photographs of vibratory, equipment, feeders, conveyors, power tools, shaft seals, diesel pile hammers, gasoline hammers, selenium rectifiers and other materials handling equipment.

**251 PLASTIC PIPE FITTINGS**

**Grinnell Co.**—A 12-page catalog on corrosion resistant pipe fittings and flanges in normal impact grade and high impact grade, rigid, unplasticized polyvinyl chloride shows characteristics, advantages and limitations. Listed are operating pressures, temperatures, applications, price comparisons, fabrication advice, installation and supporting recommendations, dimensions and weights.

**252 WORM GEAR JACK**

**Duff-Norton Co.**—An 8-page manual illustrates applications of the company's worm gear jack for raising and lowering movable parts in metalworking machinery. Included are the elevation of mill tables, rolls, conveyors, machine beds.

**253 SEPARATORS EXHAUST HEADS**

**Wright-Austin Co.**—Catalog 400 covers separators, exhaust heads, traps and strainers, boiler trimmings for steam, air, gas, oil or water service. Cutaway photos, dimensional drawings and tables are used to show the features of the equipment.

**254 VIBRATION CONTROL**

**MB Mfg. Co.**—A 12-page catalog illustrates, describes and gives specifications on vibration isolators, engine mounts, vibration test equipment and vibration control engineering. Included is an isomode design chart to assist in finding mounting points for any product design.

**255 LIQUID METERS**

**Buffalo Meter Co.**—Catalog of Niagara Industrial Meters, Bulletin No. 37 describes the company's line of volumetric meters for industrial liquids including chemicals, oils, solvents, hot water, cold water, syrups, acids, and alkalies. Automatic batch-measuring equipment is described.

**256 FILTRATION EQUIPMENT**

**Croll-Reynolds Engineering Co., Inc.**—Bulletin describes the company's method of filtration. Also included are specification data on sizes and capacities and a listing of the company's filtration facilities such as laboratory, pilot plant demonstrators and special engineering services.

**257 DIRECT FIRED HEATERS**

**Arthur A. Olson & Co.**—Bulletin A1A No-30-B-1 illustrates and describes stainless steel direct fired heaters with capacities of 300,000 to 2,000,000 Btu output. A cutaway photo and a table of general dimensions are included.

**258 DIMINUTIVE DRAFT GAGES**

**Ellison Draft Gage Co.**—Bulletin 215 describes the new line of Minified straight-line diaphragm actuated draft gages, which are about one-half the size of standard draft gages. Designed for use on compact console, graphic, or other power plant instrument panels where space is limited.


**Cleveland Trinidad votes for new**

# Pangborn WET DUST Collector

**and now makes a clean sweep of over $50 a day!**

Dust control at the Cleveland Trinidad Paving Co., Cleveland, Ohio, is necessary for efficient operation, good employee and community relations and the salvage of valuable material.

To achieve these ends, the company uses a combination of preliminary centrifugal collectors and secondary centrifugal wet collector, resulting in a salvage of materials valued at $50 per day. Cleveland Trinidad says, "This Pangborn Collector has been a very profitable investment. We investigated all types of wet dust collectors and picked Pangborn's as the best of the lot. We've had no trouble at all with this machine and will be delighted to recommend it to anyone."

# Pangborn CONTROLS DUST

*How do you Vote?*

If you're interested in efficient, profitable plant operation, cast this "ballot" for additional information on Pangborn Dust Control. Send to **Pangborn Corp., 2200 Pangborn Blvd., Hagerstown, Md.**

**CAST YOUR BALLOT**

☐ **Please send me more information on Pangborn Dust Control immediately.**

Name_____

Company_____

Address_____

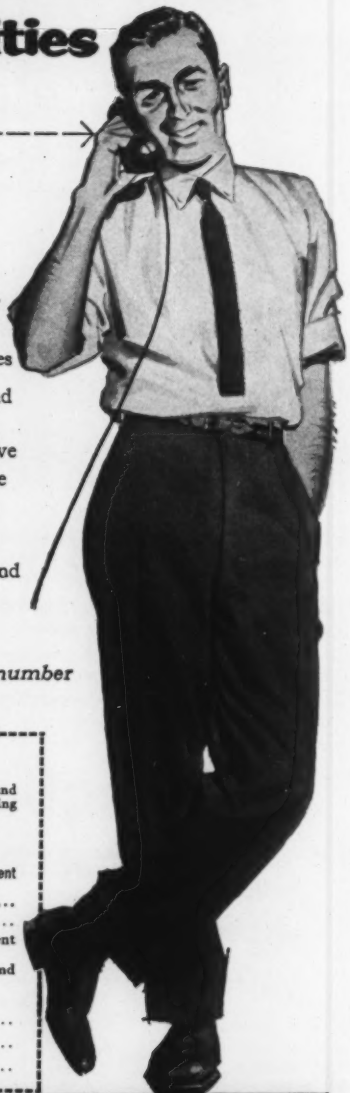
City_____ Zone_____ State_____

# Designers

## OPERATION TELEPHONE

may introduce you to

**unusual advancement opportunities**



Across the nation, we have talked by phone with men who have expressed interest in our design work. Easily, quickly they have been able to get the important facts on our attractive career opportunities

If *you* are restless — perhaps in a deadend job — mail the coupon *immediately*. Chances are we will call you shortly — give you an opportunity to verbally investigate what we have to offer.

Ability shows up fast in our design work. Some of our top men, with top earnings and responsibility, are comparatively young. It could happen to you.

*Be sure to give us your home telephone number*

Mr. E. M. Peterson, Dept. 8, Design Employment
Pratt & Whitney Aircraft, East Hartford, Conn.

I would like to learn more about your openings for product and component designers. My experience has been in the following fields:

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| ☐ Nuclear Design | ☐ Aerodynamics | ☐ Bearings |
| ☐ Compressors | ☐ Hydraulics | ☐ Piping |
| ☐ Turbines | ☐ Gears | ☐ Controls |
| ☐ Structures | ☐ Valves | ☐ Test Equipment |
| ☐ Afterburners and Related Equipment | ☐ Heat Exchangers and Combustion Problems | ☐ Test Rigs |

Total years Mechanical Design experience .....

You can reach me at ..... Most convenient (home telephone) hours for receiving calls are between .....and .....

NAME .....

HOME ADDRESS .....

CITY .....STATE .....

**PRATT & WHITNEY AIRCRAFT**

DIVISION OF UNITED AIRCRAFT CORPORATION, EAST HARTFORD 8, CONNECTICUT

*World's foremost designer and builder of aircraft engines*


## YOUR *New Catalogs* GUIDE

**259 SOCKET SCREWS**

**Allen Mfg. Co.**—General catalog, G-56, 40 pages, describes the line of hex socket screws and precision fasteners, including flat and button head cap screws, shoulder screws, pipe plugs, dowel pins, Allenuts, and hex keys. Included are engineering data and standards pertaining to socket screws.

**260 PROCESS CONTROL SYSTEM**

**Swartwout Co.**—A bulletin covers equipment for an all-electronic control system for process and power instrumentation. It can be used with a-c, d-c or motion inputs, as well as the conventional primary elements. In addition to various components, a discussion of electronic transmission and control is included.

**261 STEAM DISTRIBUTING TUBE**

**John J. Nesbitt, Inc.**—Catalog 305-1 illustrates and describes new Series T steam distribution tube type heating surface employing the principle of two steam passes in each distributing tube to eliminate stratification under modulated steam control. Each tube serves two adjacent condensing tubes.

**262 ALLOY CASTINGS**

**Curtiss-Wright Corp., Metals Processing Div.**—A booklet illustrates and describes processing of stainless steel, Niresist, Nihard, monel, nickel, high chrome and high nickel castings and shows applications of them in melting equipment, molding facilities and in the aeronautical field.

**263 COMBUSTION EQUIPMENT**

**Hauck Mfg Co.**—The Catalog 52 gives a condensed and pictorial review of oil and gas combustion equipment for production, construction, and maintenance applications in industry. The catalog has 12 pages and 80 illustrations.

**264 WOODRUFF KEYS**

**Standard Horse Nail Corp.**—Pamphlet describes woodruff keys, made from cold drawn stock ASA. Illustration in line cuts of sizes. Also mention line of machine keys, taper pins, straight pins, cotter pins and special parts.

**265 REDUCTION EQUIPMENT**

**American Pulverizer Co.**—Literature describes reduction problems of various processing industries. Construction and operating features, specifications are fully discussed and illustrated. Bulletins are available on coal crushers, stone crushers, metal turnings crushers, plastics granulators, wood hogs.

**266 INDUSTRIAL PLASTICS**

**H. N. Hartwell & Son**—Catalogs and technical bulletins describe Boltaron 6200 corrosion resistant unplasticized polyvinyl chloride sheet, pipe, pipe fittings, valves, bars, blocks, and welding rod, as well as Boltaron 7200 modified high impact PVC sheet and pipe materials.

**267 HEAT EXCHANGERS**

**Griscom-Russell Co.**—Bulletin 1401 describes the twin G-Fin section heat exchanger, with longitudinally finned tubes for maximum heat transfer between dissimilar fluids, and for use on heating, cooling and condensing services. Design details, representative installations, complete specifications and dimensions are included.

**268 MOTOR ROTATION TESTER**

**James G. Biddle Co.**—4-page bulletin No. 80 illustrates, describes and gives operating information on motor and phase rotation tester for determining the direction of rotation of electric motors before they are connected to the line and determining the phase rotation or sequence of energized power circuits.

**269 PLUG VALVES**

**Homestead Valve Mfg. Co.**—A 28-page reference book, No. 39-5 shows lubricated plug valves in full-port and venturi types, sizes up to 20 in., with a choice of standard, round port or diamond port plugs. Engineering information includes principal dimensions, types of control, metals.

YOUR *New Catalogs* GUIDE

**270 PIPELINE APPLICATIONS**

**Ladish Co.**—A 21-page manual provides data on five fittings developments for pipeline and petroleum industry applications. The developments concern hot tap reinforcing tees, multiple outlet fittings, extra long radius elbows, pipeline anchor flanges, seamless multiple outlet fittings.

**271 DEMINERALIZATION**

**Graver Water Conditioning Co.**—Bulletin WC-111, 22 pages, covers chemical and mechanical factors entering into the design and operation of demineralizing plants for obtaining the highest quality process water and boiler feedwater from a wide range of water supplies under many different operating conditions.

**272 SAFETY MARKING TOOLS**

**M. E. Cunningham Co.**—Catalog No. 100, 28 pages, illustrates and describes more than 100 different marking tools and devices. Also included is information on Mecco safety steel, a specially-developed alloy which is said to reduce spalling and mushrooming, and to increase marking life.

**273 HIGH PRESSURE COMPRESSORS**

**Norwalk Co., Inc.**—Catalog No. 44 illustrates and describes multi-stage high pressure air and gas compressors. Included are single and two stage compressors, three stage compressors, semi-portable compressors, four stage, five stage and six stage compressors, boosters and special compressors, vertical compressors, conversion tables and installations.

**274 DUST AND FUME COLLECTORS**

**Northern Blower Co.**—Catalog 1002-6 describes exhaust fans for dust collecting and air handling and includes complete performance tables, test curves, etc. Plans and elevations of typical dust-collecting installations are shown. Separate additional bulletins contain descriptions, dimensions, capacities, etc., of Norblo bag type, hydraulic type, and centrifugal dust collectors.

**275 EXPANSION COMPENSATORS**

**Flexonics Corp.**—Bulletin AIA No. 30-C-22 illustrates and describes expansica compensators for steam and hot water lines. Included is data on a high pressure type to 150 psi and a low pressure type to 40 psi.

**276 OIL-RETAINING BEARINGS**

**Bound Brook Oil-Less Bearing Co.**—More than 600 of the most widely used sizes of oil-retaining porous bronze bearings are listed in the firm's Stock List No. 4. Also provided is condensed information on application, installation, lubrication and machining.

**277 HOT-DIP GALVANIZING**

**American Hot-Dip Galvanizers Assn.**—A 16-page booklet outlines rust prevention in industrial and consumer products through the use of the hot-dip galvanizing process. Included are photographs of products made by the method, and illustrations of production and quality control. A chart compares the method with other types of rust prevention.

**278 ELEVATOR CHAINS**

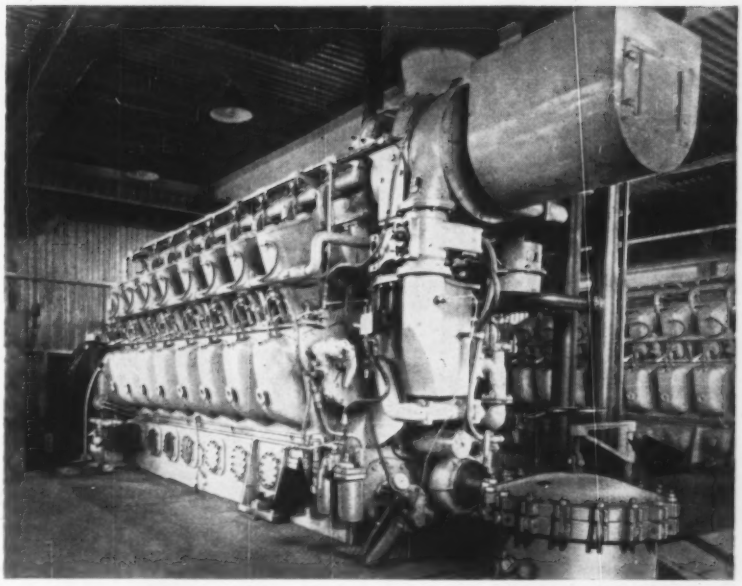
**Beaumont Birch Co.**—How service life of elevator chains can be increased from 300 to 400 per cent over conventional chains is stated in Catalog DC-855. Dimensional drawings, tables of physical properties and relative corrosion resistance for various types of chain metals are included. Details on wheel pitch diameter are given.

**279 QUENCHING OIL**

**Gulf Oil Corp.**—A 24-page brochure, "Gulf Super-Quench," describes function of dual-action quenching oil for a wide range of steels. It explains mechanism of heat removal, effect of variation in bath temperature, degree of agitation, mass effect on depth of hardening. Charts and curves depict comparison with several quenching media. Tests to determine depth of hardness, distortion and cracking are discussed.

**280 FORGING HISTORY**

**Drop Forging Assn.**—"What is a Forging?" is an eight-page booklet which covers the advantages of producing metal parts by forging. Also included is a history of forging.

# NUGENT FILTERS
## . . . The best protection any engine can have

Nugent Filters protect both lube and fuel oil for the Alco 251 Diesels installed at the Laton (Kansas) Pumping Station of the Service Pipe Line Company. This recently built pipeline conveys crude oil from Fort Laramie, Wyoming, to Freeman, Missouri.

To help guard against the serious consequences of a power failure, a Nugent #1555-4L12 filter provides the Alco Diesels with full flow filtering of lube oil. The filter cleans all the engine lube oil in circulation every cycle before going to the bearings, removing particles as small as 2 or 3 microns.

Fuel oil, too, receives the protection of Nugent filtering. A #1555-BF-1R Duplex Filter is mounted on the suction side of the fuel oil pump—protection for trouble-free injection.

You can prevent harmful impurities from reaching spots where they can accelerate wear, shorten engine life or cause power stoppage by employing Nugent Filters. They offer a choice of full flow or by-pass filtering with the same unit. Recharges are inexpensive and easy to change. Simple piping makes installation no problem.

Let Nugent show you how to insure long engine life—write for descriptive literature.

NUGENT TRADE MARK

Established 1897

**Wm. W. Nugent & Co., Inc.**

3412 Cleveland St. Skokie, Illinois

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

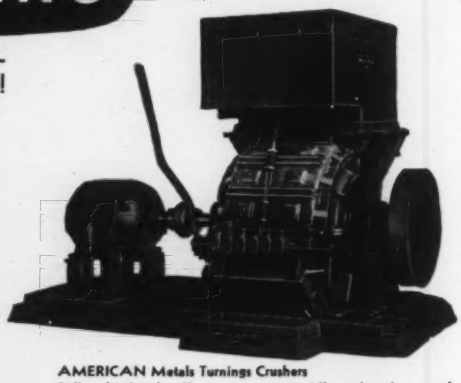
Representatives in Boston • Cincinnati • Detroit • Houston • La Junta, Colo. • Los Angeles Minneapolis • New Orleans • New York • Philadelphia • Portland, Ore. • San Francisco Seattle • St. Louis • Tulsa • Representatives in Canada: Montreal • Toronto • Vancouver

# from TEST GRINDING to TONNAGE CRUSHING

**AMERICANS are custom-built to do a *better* job!**

**AMERICAN Laboratory Size Mills**

**With the same reduction action as Metal Turnings Crushers (or hammer action)—American Laboratory Size Mills offer an efficient means for reducing razor blades, pewter castings and fragile thin brittle steel to a reclaim product.**



**AMERICAN Metals Turnings Crushers**

**Bulky, hard-to-handle turnings are rapidly reduced as much as 80% with this efficient, economical crusher. And the yield of cutting oil is increased 30 to 50 gallons per ton—proof of how profitable the installation of an American Metal Turnings Crusher can be for those who handle 20 tons or more of metal turnings a month.**

**There's a custom-built AMERICAN for your operation—write for further data and specifications.**

**American PULVERIZER COMPANY**

*Originators and Manufacturers of Ring Crushers and Pulverizers*

**1541 MACKLIND AVE. ST. LOUIS 10, MO.**



# Select California engineering group explores thermodynamic cycles in advanced engines

*positions now open for Cycle Analysis... Thermodynamics... and Nuclear Engineers*

Propulsion experts at North American Aviation's Los Angeles Division are carrying out thermodynamic analyses of highly advanced engines. The studies include investigation of turbojets, ramjets, rockets and nuclear propulsion devices...compressors, combustors, turbines, afterburners, exhaust nozzles and thrust augmentation devices.

The Engineering Personnel Department at North American's Los Angeles Division is seeking several qualified engineers who are interested in this work. They are looking for men who have had a minimum of three years thermodynamics cycle analysis experience in jet engines or propulsion analysis. Advanced degrees are preferred, though not required.

**Interested engineers are invited to contact Mr. W. H. Nance, North American Aviation, Inc., Los Angeles Division Engineering Dept. 56-ME, International Airport, Los Angeles 45, California.**


## YOUR *New Catalogs* GUIDE

**281 UNIT STEAM GENERATOR**

**Preferred Utilities Mfg. Corp.**—A 26-page booklet illustrates and describes the design and construction features of unit steam generators. Application photos, checklists and dimension tables are included.

**282 RETAINING RINGS**

**Eaton Mfg. Co., Reliance Div.**—A catalog describes the design and application of the firm's line of snap bearing lock and retaining rings, spring lock washers, spring washers—preassembled on bolt or screw—self-tapping screws, one-piece hose clamp.

**283 REGULATING VALVES**

**Atlas Valve Co.**—Condensed Catalog 56C describes broad line of temperature and pressure actuated control and relief valves and governors for power, marine, chemical process, petroleum and related industries. Design makes use of alloys and packing materials to provide long life, rugged and sensitive controls.

**284 STAINLESS STEELS**

**G. O. Carlson, Inc.**—A four-page folder shows applications of stainless steel in plates, plate products, heads, rings, circles, forgings, flanges, bars, sheets. Products, equipment and services of the firm are discussed.

**285 LITERATURE DIRECTORY**

**Allis-Chalmers Mfg. Co.**—Bulletin 25B6057 provides an alphabetical description of company products and their descriptive literature along with a brief history of the firm.

**286 METERED LUBRICATION**

**Bijur Lubricating Corp.**—A four-page bulletin "The ABC of Modern Lubrication" describes automatic lubricating system components. All systems consist of a lubricator, distribution system and a Meter-Unit for each bearing served. The bulletin describes lubricators for rotary, oscillating, hydraulic, solenoid, or hand operation.

**287 BEARINGS, BUSHINGS**

**Cleveland Graphite Bronze Co., Div. Clevite Corp.**—A 16-page Catalog gives data on engineering, material analyses and applications of bearings, bushings, wear plates, thrust bearings and related products.

**288 ELECTRICAL PRECIPITATORS**

**Research-Cottrell, Inc.**—Illustrated General Bulletin, 28 pages, describes Cottrell theory, methods, types, and specific applications in a variety of industries, including power, steel, chemical paper, metallurgical, gas, oil, and carbon black.

**289 HUMIDITY CONDITIONING**

**Kathabar Div., Surface Combustion Corp.**—An 18-page Booklet shows applications of humidity control equipment in various industries. Problems, solutions and results of 12 case histories are included, along with data on how the system works.

**290 SILENT CHAIN**

**Link-Belt Co.**—A 16-page bulletin, No. 2510, describes a tiny, precision-built chain with positive contact of gears designed for installation in compact spaces on such machines as motion picture projectors, recording devices, portable sanders and planers. The chain is available in side-flange, middle-guide and duplex types in a variety of widths.

**291 GAS COMPRESSOR VALVES**

**J. H. H. Voss, Inc.**—Bulletin 53-G covers Voss Valves for the replacement of worn or inefficient valves in air, gas, and ammonia compressors. The valves are machined from solid stock and plates are machined and ground; valves and plates are of heat-treated alloy and stainless steel, and are designed to specification to fit the individual compressor for which they are manufactured.

**292 METER TESTING**

**Hydraulic Products Co.**—Bulletin is illustrated with installation photographs of air-water testing of gas meters ranging from five to sixty light by an air-mechanical lifting and depressing device providing multiple loading.

YOUR

## *New Catalogs* GUIDE

**293 PRESSURE VESSELS**

**L. O. Koven & Bro., Inc.**—Bulletin No. 550 illustrates and describes mixers, kettles, vacuum and pressure vessels, autoclaves, evaporators, impregnators, condensers, stills, extractors, tanks, standpipes, piping, stacks.

**294 ELECTRIC WELDED TUBING**

**Jones & Laughlin Steel Corp.**—Literature gives specifications and characteristics of Electricweld tubing and its application on automobiles and in bicycle and furniture frames.

**295 FLUID POWER EQUIPMENT**

**Oilgear Co.**—A 12-page Bulletin 10051-E gives condensed information and specifications on equipment for fluid power transmission applications. It covers constant and variable delivery, duplex and automatic feed pumps, constant and variable displacement motors, hydraulic motors with reducers, variable speed transmissions, standard and heavy-duty cylinders, pilot, directional, relief, foot, surge, combination and differential valves.

**296 STEEL WIRE**

**American Chain & Cable Co., Page Steel & Wire Div.**—A 16-page, DH-1226, catalog on Page shaped wire includes specification tables, range of sizes, physical properties of steel wire, table of standard wire gages, hardness conversion tables, with illustrations showing how to calculate areas of typical common shapes of wires. Size range includes cross-sectional area up to and including No. 3 BWG; flats and rectangles in widths up to 3/8 in., the ratio of width of thickness not exceeding 6 to 1.

**297 BOILERS**

**Brown Fintube Co.**—Bulletin No. 554 illustrates and describes the construction, operation, controls of boilers in capacities of from 30 to 350 hp. Dimensions and specifications are tabled.

**298 FLEXIBLE METAL HOSE**

**Atlantic Metal Hose Co.**—Bullein 20-E covers corrugated flexible metal hose of annular and helical construction. Steel and bronze hose, with and without metal braid, couplings and assemblies are described. Applications listed are for vibration absorbing, misalignment connecting, high pressure use, oil burner and gas furnace connections, handling compressed air, steam, solvents, chemicals, refrigerants, gasoline, searching liquids, caustics, ammonia.

**299 ISOLATION EFFICIENCY CURVE**

**Lord Mfg. Co.**—Bulletin No. 901 contains a vibration isolation efficiency curve as a guide to the selection of flexible mounting systems for equipment where noise and vibration control is desirable. The curve shows, for simple linear vibration, the percentages of vibration or noise reduction obtainable with mountings of different static deflections where the disturbing frequency of the assembly is known.

**300 PIPING INSULATION MANUAL**

**American Gilsonite Co.**—A 20-page Booklet covers the methods of application of Gilsulate, a new insulation for hot underground pipes. It describes the three grades, how to determine ditch size for various pipes and types of soil, and gives sample problems.

**301 TURBINE SEAL**

**Koppers Company, Inc., Metal Products Div.**—A 4-page folder on Huhn carbon rings for steam turbine applications discusses labyrinth, carbon garter spring ring and carbon ring sealing devices.

**302 ATOMIC MATERIALS**

**Norton Co.**—A 16-page instructional booklet covers the use of boron carbide and elemental boron in the atomic energy program. Tables and curves of properties are included in this illustrated booklet.

**303 ULTRASONIC TESTER**

**Sperry Products, Inc.**—An eight-page bulletin covers applications of the ultrasonic Reflectoscope for nondestructive testing of products and equipment. It explains in simplified terms the principle of ultrasonic inspection and lists the latest types of equipment available.


FIGHT VIBRATION WITH VIBRATION

# How many jobs can a vibration exciter do?

SHAKER SYSTEMS can help you in *at least* five important ways.

**Fatigue testing.** Shakers have both the range and capacity to determine fatigue limits of structural members, assemblies, aircraft wing and tail structures. Peak forces of up to 25,000 pounds are now obtainable with MB Exciter Systems.

**Environmental vibration testing** to MIL-E-5272 and other government specifications. This is most important now for assuring reliability of performance in military production. But the same techniques can be used also to improve *all* types of products.

**Noise.** Just where in a product does it come from and how to eliminate it? An MB shaker helps pinpoint the disturbance by letting you vibrate the product through a whole range of frequencies with the twist of a dial.

**Complex wave testing,** including random motions. This is something *new!* It subjects a specimen to the same kind of vibration as that encountered in actual service. MB electrodynamic shaker systems offer the frequency range, high acceleration, and freedom from distortion needed for this kind of job.

**Production and Quality Control.** *Your* ideas are needed here. For example: Someone discovered that size of fine powder particles which sift readily through a screen varies with the screen's frequency of vibration. Permitting easy control of frequency, an MB shaker is capable of working on a *production* line! Tubes too are being production-tested with MB Exciters.

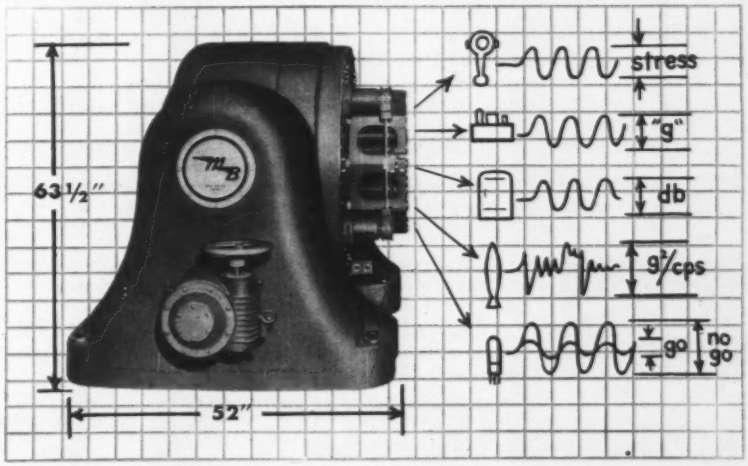
If you need help in putting vibration exciters to work, get in touch with MB . . . leading producer of vibration test equipment.

MB *manufacturing company*

A DIVISION OF TEXTRON INC.

1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO ISOLATE . . . EXCITE . . . AND MEASURE VIBRATION



### 304 LPD STRAINERS

**J. A. Zurn Mfg. Div., Zurn Industries, Inc.**—Several types of LPD (Low Pressure-Drop) Strainers for all purposes and ranging in sizes from 1/2 to 24 in. are described and illustrated in this 16-page Data Manual No. 952. It carries information concerning the factors to be considered in selecting strainers for a specific application, and the effect of flow rate, screen loading, and the viscosity of fluid on pressure drop.

### 305 SELF-OILING BEARINGS

**Chrysler Corp., Amplex Div.**—Oilite self lubricating bearings are covered in a 24-page catalog, S-56, listing more than 1000 standard sizes of sleeve, flange and thrust bearings that are available from stock. In addition over 250 stock sizes of cored, bar and plate stock are shown. A comprehensive engineering section covering Oilite bronze applications is included.

### 306 O-RINGS

**Linear Inc.**—Compact 12-page folder contains tables of standard O-ring sizes as well as dimensional data for installation. Notes contain general recommendations on clearances, design material, machining, and finishes for most O-ring applications. A special compound bulletin describing the latest polymers and synthetic rubbers from which O-rings can be molded is also included.

### 307 AIR HYDRAULIC PUMPS

**Ledeen Mfg. Co.**—An eight-page folder illustrates and describes the company's line of air hydraulic pumps and power units for the operation of high pressure cylinders, clamps, valves, actuators. Application layouts, ratings and dimensions are shown.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### 308 TRANSMISSION BELTS

**United States Rubber Co., Mechanical Goods Div.**—An 82-page booklet illustrates and describes the firm's timing belt drive, a thin belt with teeth that makes positive engagement with axially grooved pulleys. Horsepower ranges from 1/100 to 600 for power transmission.

### 309 HIGH TEMPERATURE ALLOY

**Firth Sterling, Inc.**—Literature covers specifications of 2 high temperature alloys for aeronautical use. Composition, general characteristics, typical applications, forging, general heat treatment, corrosion resistance, welding properties, machinability, physical constants, tensile properties. Hardness values and fatigue values are included.

### 310 GASKET DESIGN

**Armstrong Cork Co.**—A 26-page manual on gasket design covers gasket requirements, characteristics and uses of gasket materials, selection data, specifications and testing, stress-strain characteristics of resilient materials, effect of changes in gasket shape, effect on surface conditions, sealing with confined resilient gaskets, joint and gasket design, common errors in gasket design, determining gasket compression and flange bending.

### 311 WATER CHILLERS

**Trane Co.**—Bulletin DS-399, 56 pages, discusses the features of hermetic centrifugal water chilling units, their applicability to comfort and process jobs, their operational features, component parts, refrigerants used, capacities, controls, roughing-in dimensions, piping connections, and engineering specifications for selection.

### 312 MOTOR SPEED CONTROLS

**General Radio Co.**—An 8-page booklet contains characteristics, photographs, applications, and prices of line of Variac motor speed controls. Models from 1/10 to 1 1/2 hp are available.

### 313 PIPE COUPLER

**John Bean Div., Food Machinery & Chemical Corp.**—A folder illustrates and describes a fast move coupler designed for use with any make portable aluminum pipe for pumping brine, natural gas, crude oil, butane, water in the petroleum industry.

### 314 PROPORTIONING PUMP

**Hills-McCanna Co.**—A 12-page booklet, No. 600, illustrates typical installations for the injection of inhibitors in water conditioning systems using the firm's proportioning pumps. Included are pump specifications, a table listing the chemicals most commonly used in water conditioning, what they are used for, and the pump construction best suited to inject them.

### 315 WATER VAPOR PHYSICS

**Pittsburgh Lectrodryer Company**—Bulletin No. 218, "The Moisture in Our Atmosphere," a 12-page bulletin, discusses the fundamental physics of water vapor. The nature and behavior of water vapor are treated in a logical down-to-earth manner with psychrometric chart explanations. Solid adsorption equipment for dehumidification.

### 316 MULTI-PURPOSE STEEL

**Lukens Steel Co.**—A 24-page bulletin describes the properties and handling characteristics of a new multi-purpose steel, T-1. Suggested uses include applications where extreme toughness and high yield strength are needed for economies in fabrication, payloads, maintenance and equipment life.

### 317 PUMP CONTROL

**McDonnell & Miller, Inc.**—A bulletin illustrates and describes the firm's 91 series for installations up to 150 psi and 92 series for installations up to 250 psi of magnetic switching pump control, low water cutoff and alarm switch.

### 318 WATER SOFTENERS

**Cochrane Corp.**—A 20-page publication, No. 4520, deals with the necessity for water softening, explaining the fundamentals of softening and selection of equipment and zeolites. The bulletin also describes the operation of the firm's hydromatic valve for manual or automatic control of the cycling of the process.

YOUR *New Catalogs* GUIDE

### 319 CONTROL INSTRUMENTS

**Consolidated Electrodynamics Corp.**—A 12-page catalog illustrates and describes the company's analytical mass spectrometer, leak detector, isotope-ratio mass spectrometer, dual-purpose mass spectrometer, micromanometer, process-monitor mass spectrometer, titrilog, spectrosadic, analytical service. Another booklet contains case histories of the firm's instruments in various industries, and another outlines the company's Systems Div. services in dynamic and static testing, chemical analysis, process monitoring and control.

### 320 COMBUSTION EQUIPMENT

**Todd Shipyards Corp., Products Div.**—Literature describes various types of oil, gas, and combination burners, asphalt heaters, thermo air heaters, package burner units, combustion chambers, pressure vessels, pumping, heating and straining units, TIFA—Todd insecticidal fog applicators.

### 321 CENTRIFUGAL COMPRESSORS

**Clark Bros. Co.**—Bulletin 116, 32 pages, illustrates and describes the company's line of centrifugal multi-stage compressors for high capacities. Units shown run from 1000 to 18,000 cfm and 12,000 to 65,000 cfm. Application photos, cutaways of design features, construction details, engineering data and performance characteristics are included.

### 322 RADIAL ROLLER BEARINGS

**Rollway Bearing Co.**—A 56-page catalog gives tabular information on radial static and dynamic capacities and introduces thrust capacities recently computed for the firm's line of maximum type, precision radial roller bearings.

### 323 KILN GEARS

**Falk Corp.**—Engineering Report 6171 describes and illustrates the science of manufacturing large precision mill and kiln gears. This report is available to companies that use or manufacture mills of kilns 6 ft or larger in diameter.

### 324 LARGE D-C MOTORS

**General Electric Co.**—Large d-c motors, 250 to 8000 hp, are described and illustrated in Bulletin GEA-5643. Applications include metal rolling mills, metal processing lines, mine hoists, paper machines, rubber mills, oil-well drilling rigs, large fans and blowers, line shafts.

### 325 VARIABLE SPEED DRIVES

**Sterling Electric Motors, Inc.**—An 8-page bulletin illustrates and describes variable speed drives for metal working, mixing, pumping, materials handling and continuous processing. Engineering, selection and operating data is included. Also available is a revised price sheet.

### 326 POLYETHYLENE

**Koppers Company, Inc., Chemical Div.**—Bulletin C-6-216 illustrates and describes the properties, processing and application of an improved polyethylene material. Sections cover heat resistance, rigidity, chemical resistance, low temperature toughness, tensile strength.

### 327 GAS-FIRED HEATERS

**Reznor Mfg. Co.**—Catalog CN-56 covers specifications, application and installation of gas-fired unit heaters and duct furnaces. The equipment ranges in size from 25,000 to 250,000 Btu for unit heaters and 50,000 to 250,000 Btu for section duct furnaces.

### 328 SPHERICAL ROLLER BEARINGS

**S K F Industries**—Bulletin 365 discusses in detail the company's improved (Type C) spherical roller bearing said to increase capacity 25 to 50 per cent and service life 2 to 3½ times. A tabulation of capacity comparisons, and life comparisions between the original spherical design and the Type C is also given.

### 329 PHOTO REDUCTION PROCESS

**Ampower Corp.**—A folder illustrates and describes the Lumotrace system, a precision photographic reduction of scaled drawings and subsequent projection of the full size image on the work piece to be marked. The system is said to eliminate templates and allow positioning of component parts on the drawing board rather than in the shop.

### 330 DEAERATOR

**Permutit Co.**—Bulletin No. 3677 describes the company's reboiling deaerator with direct contact internal vent condenser which operates efficiently over a wide range of flows. The three stages of deaeration are described and well-illustrated. The unit is designed to protect equipment from corrosion by removing oxygen, carbon dioxide and nitrogen.

### 331 OSCILLOSCOPE CAMERA

**Brea Instruments**—Data sheet describes high speed oscilloscope camera model OC-1 designed to photograph the signal on a cathode ray oscilloscope screen on a film strip moving uniformly in a direction across that of the signal. Specifications of film, film speed, optics, speed control and accessory reflex camera mount are given, along with a discussion of operating principles.

### 332 DRAWING INKS

**Higgins Ink Co.**—A brochure describes the firm's line of drawing inks, India inks, waterproof colored inks, art books, accessories, pen cleaner and ink assortments. Also included is a section on how to dilute inks.

### 333 ELECTRIC HEATERS

**Edwin L. Wiegand Co.**—Catalog D-52 illustrates and describes electric blower-type portable unit heaters, wall and ceiling mounted unit heaters, forced air heaters for large areas, radiant and convection comfort heaters, thermostats and contactors for commercial and industrial use.

### 334 HIGH TEMPERATURE WATER GENERATORS

**International Boiler Wks. Co.**—High temperature water generators are described in a 10-page bulletin, No. 700. Covered are specific features of forced recirculation generators; reasons are given on why high temperature water systems are being selected in preference to high pressure steam systems.

### 335 FUME HOODS

**Kewaunee Mfg. Co.**—A 12-page bulletin illustrates and describes fume hoods for protecting laboratory equipment by disposing of corrosive and hazardous fumes and airborne particulate matter. Comparisons of the hoods' characteristics, standard and special models, and application photos are included.


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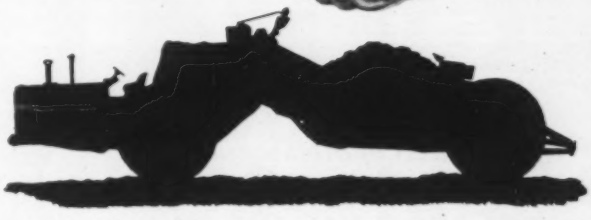

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**336 PNEUMATIC CONVEYORS**

**National Conveyors Co.**—Catalog P-56 shows uses of pneumatic conveyors for ash removal in steam plants; collection, processing and reclamation of cutting oils, chips, and borings in the metal working industry; and the handling of dry, pulverized or granular materials in other industry.

**337 DRAFTING MACHINES, INSTRUMENTS**

**V. & E. Mfg. Co.**—16-page booklet describes and illustrates Vemco drafting machine, plus vertical and detail models and various scales. 20-page booklet covers company's line of drawing instruments and materials.

**338 PANEL ENGINEERING**

**Leeds & Northrup**—A 12-page catalog illustrates and describes design and construction of centralized control boards for steam power plants. Application photos are included along with background and photos on the company's facilities for designing and installing control units.

**339 CODE PRINTERS**

**Pannier Corp.**—A bulletin illustrates and describes special code printers use for marking sheet products. Included is a sheet surface printer, drum type printing roll, handle-feed single wheel printer, adjustable multi-wheel printer, and shaft feed drum type printing unit.

**340 STOKER PIERS AND SILLS**

**Bernitz Furnace Appliance Co.**—Brochure describes advantages of air-cooled "Carbofrax" piers and sills in new construction as well as replacement. Pictorially depicts typical installations. Points up savings in maintenance and boiler outage or downtime, improved combustion and elimination of spalling, fly ash and clinker adhesion.

**341 CONVEYOR APPLICATION**

**Falk Corp.**—Report 550902 illustrates the application of speed reducers and flexible shaft couplings on conveyor drives in a large, modern limestone quarry.

**342 PACKAGED STEAM GENERATORS**

**Superior Combustion Industries, Inc.**—Packaged fire tube steam generators are described in detail and with illustration in a 16-page catalog with a special foldout cover. Data, dimensions and specifications for units in 18 sizes from 20 to 600 bhp and for operation burning oil or gas or both are included.

**343 DUST-SPOT TESTER**

**Research Appliance Co.**—A four-page folder illustrates and describes Dill dust-spot testers to measure the efficiency of all types of air filters in ventilating systems. It is said to be the first portable instrument commercially available to make rapid determinations at the point of installation.

**344 PISTON, SEALING RINGS**

**Koppers Company, Inc., Metal Products Div.**—A 24-page brochure illustrates and describes American Hammered piston and sealing rings for various types of industrial applications. Engineering data, tables, and types of material are included. Also available are 4-page folders on conformable oil ring, marine piston rings, chrome-plated piston rings, and piston rings for air and steam forging hammers.

**345 EXPANSION-JOINT DESIGN GUIDE**

**Flexonics Corp.**—A 24-page Flexon Expansion Joint Design Guide, Catalog 153, covers engineering application and selection data necessary to the proper solution of pipeline expansion problems. Features of the Flexon Design Guide include a discussion of the various types of expansion joints on the market, the many types of Flexon Expansion Joints available, and types of pipeline motion solved by expansion joints; also expansion joint design considerations, installation instructions, and selection data. The new line of Model H compensators is completely covered. The center spread of the catalog is devoted to a schematic piping layout illustrating various expansion joint applications and principles.

**346 DIGITAL CONVERTER**

**Fischer & Porter Co.**—Catalog 58-10 illustrates and describes the firm's line of digital converters, electro-mechanical shaft position types and volt-

YOUR *New Catalogs* GUIDE

age types. Operation, characteristics, accuracy and specifications are described and illustrated with photos, drawings and installation diagrams.

### 347 HYDRAMOTOR VALVES

**General Controls Co.**—A 50-page catalog describes the firm's newly expanded line of Hydramotor valves (motor-operated) for remote control of all industrial liquids and gases, shutoff, three-way, and proportioning control. Engineering data section for use in selection and application, flow characteristics, charts and tables are included.

### 348 BALL BEARINGS

**T. B. Wood's Sons Co.**—Life-Lube bulletin No. 699 illustrates with dimensional information pillow blocks, flange units, take-up units. These standard 200 series bearings with wide inner ring, deep ball race groove are lubricated for life at the factor. They are completely self-aligning. Sizes range from $^{1}/_{2}$ to $2^{15}/_{16}$ in.

### 349 LIQUID LEVEL ALARMS

**Reliance Gauge Column Co.**—Bulletin D2 describes a series of four liquid level alarms and optional fuel cut-outs. Illustrated text explains principle of operation—water conduction between electrodes of varying lengths—and how the units can be used with relays to provide alarm actuation, fuel cut-out, or pump start-stop control.

### 350 FLEXIBLE SHAFTING

**Elliott Mfg. Co.**—Circular 247 shows applications of flexible shafting in conveyor systems, printing machines, outboard motors, gas engines, mixers, grinders, farm and automotive equipment. A selection chart is also included.

### 351 TANKS, PIPE HEATERS

**Hynes Electric Heating Div., Turbine Equipment Co.**—Supplement 202A describes the arrangement of tubular electric heaters in storage tanks for heating viscous liquids. Supplement 202B describes the arrangement of tubular electric heaters within pipe lines for 100 per cent heat transfer.

### 352 FLEXIBLE COUPLINGS

**Poole Foundry & Machine Co.**—A 136-page manual illustrates, describes and gives engineering specification and lubrication data on flexible couplings.

### 353 OIL SEALS

**National Seal Div., Federal-Mogul-Bower Bearings, Inc.**—Oil seal catalog illustrates complete line, gives types and sizes of leather and synthetic rubber oil seals, synthetic seals with metal or rubber covered outside diameters, contains design suggestions, drafting information, application data, and installation tips.

### 354 HYDRAULIC FLUIDS

**E. F. Houghton & Co.**—Folders describe a new series of fire resistant hydraulic fluids supplementing the aqueous base fluids marketed by the firm. These are phosphate ester type fluids that have been fortified by the addition of materials to increase oiliness and rust prevention.

### 355 CONTROL SYSTEMS

**Daytronic Corp.**—A 6-page folder illustrates and describes linear variable differential transformer measurement and control systems for indication and recording, automatic control, alarm or safety shutoff, oscillographic studies. A discussion of LVDT operating principles is included.

### 356 METAL PARTS DRY CLEANER

**Curran Corp.**—A catalog sheet describes Carbon Met as a replacement for carbon tetrachloride for degreasing motors, generators and electrical components. The material is said to have low toxicity, nonrust inducing qualities and nonpolar properties.

### 357 GENERAL PURPOSE COMPUTER

**Bendix Aviation Corp., Computer Division**—Bulletin 2-4 illustrates and describes all purpose computers for processing data, solving mathematical problems and for control functions. Model 15-D is a stored program, general purpose computer using an improved two address command system; with the addition of a complete digital differential analyzer accessory the 15-D is an all purpose computer.

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## YOUR New Catalogs GUIDE

**358 CLUTCHES, COUPLINGS**

**Hilliard Corp.**—Catalog MP-5 lists and illustrates a line of industrial clutches and couplings including slip clutch, over-running clutch, single revolution clutch, and automatic centrifugal coupling. Brief description of operation is a guide to suggested applications of each item.

**359 TRACING PAPERS**

**Latmer Sales Co.**—A folder contains samples of tracing papers with 4 × 4 non-reproducing cross sections, standard headings, title block and borders. A price list is included.

**360 PRESSURE PILOT**

**Hammel-Dahl Co.**—New 12-page Bulletin No. 110 in three colors presents description of performance and operation of a pilot which provides control over a 1 to 100 per cent span of the Bourdon tube range. Reversing action and setting the three control actions—proportional, on-off, or differential gap—are described in detail and illustrated with photographs, tables, schematic sketches, and isometric views. Mounting, dimensions, and Bourdon tube ranges and materials are included.

**361 FORCE GAGE**

**W. C. Dillon & Co.**—A six-page bulletin illustrates and describes a mechanical force gage designed to measure mechanical forces in either compression or tensile in limited space. Ranges 0–10 up to 0–50,000 lb with accuracy of within 1 per cent.

**362 INDUSTRIAL PRODUCTS**

**American Brake Shoe Co.**—First complete catalog, 48 pages, 2 colors, illustrates representative parts produced by eleven divisions of the company and details physical properties or characteristics. The catalog contains sections on ferrous castings, non-ferrous castings, bearing materials, sintered metals, steel forgings, welding products, air compressors, industrial pumps, dredge pumps, and railroad products.

**363 HYDRO-MECHANICAL DEVICES**

**Pathon Mfg. Co.**—Bulletin No. 22, 32 pages, illustrates and describes oil hydraulic cylinders and valves. Included are diagrams of dimension tables covering cylinders, connecting eyes, mounting brackets, rams and valves.

**364 MATERIALS HANDLING EQUIPMENT**

**Allen-Sherman-Hoff Co.**—Data sheets on hydraulic and pneumatic materials handling systems and components describe and illustrate application, design and construction, operation, dimensions (for components) and typical arrangements. Engineering charts and technical data are also included.

**365 BRONZE PRODUCTS**

**American Crucible Products Co.**—A 12-page bulletin illustrates and describes the company's engineering service, plant and laboratory facilities and discusses bronze bushings, bearings, bar stock and babbit metal. Technical data and application photos are included.

**366 TIMING MOTORS**

**General Electric Co., Telechron Motors**—Bulletin IS-150 describes the advantages of Telechron synchronous timing motors and lists specifications of different models. Telechron instrument movements are included. Typical applications are illustrated.

**367 LOADING ARM**

**Chiksan Co.**—Four-page Bulletin 1055 covers hydraulically controlled marine loading arms and shows operational advantages enabling one man at a remote control point to place flange end of 6, 8 or 10 in. aluminum loading arm aboard largest tanker. It operates from 220/440 v, 3 hp motor, 7.5 gpm hydraulic pump.

**368 PAPER BURST TESTER**

**Ashton Valve Co.**—A bulletin describes new paper burst tester No. 98 said to make paper burst testing a simple, foolproof operation. Clamping and bursting are handled by one simple mechanism without the use of levers.

YOUR *New Catalogs* GUIDE

### 369 SPRING CLUTCHES

**Marquette Metal Products Div., Curtiss-Wright Corp.**—A pocket-sized manual illustrates and discusses the basic principles of spring clutches and their design. Included are diagrams of various types of spring clutches, along with application data.

### 370 TECHNICAL BOOKS

**Lefax Publishers**—Over 2000 listings of Lefax pocket-size technical books are contained in the newly revised 1956 Lefax list of technical data sheets. Condensed, mathematically accurate source materials for engineers, construction men, technical workers, and technical students. Each book consists of approximately 140 pages of easily read tables and data in pocket-size, loose-leaf form for handy reference right on the job.

### 371 ROTARY ELECTRICAL UNITS

**Western Gear Wks., Electric Products Div.**—Bulletin 254-A contains specifications and diagrams of the firm's permanent magnet and wound field d-c motors, a-c motors with and without gear reduction, a-c/d-c generators, motor and fan assemblies, axial flow blower assemblies, centrifugal blower assemblies.

### 372 TIMERS

**Cramer Controls Corp.**—A 4-page bulletin covers Cramer's line of interval timers, reset timers, duplex-cycle timers, time-delay controllers, cycle timers, percentage timers, running-time meters, reversing motor timers, multi-contact timers, and time totalizers. Features of the synchronous motor used are emphasized.

### 373 STRUCTURAL PANEL

**Philip Carey Mfg. Co.**—A folder describes a 2-in-1 insulated structural panel for interior use in duct construction, industrial ovens, coil housings, plenum chambers. It is formed of laminated plies of corrugated and flat asbestos paper sheets, bonded with a fire-resistant adhesive.

### 374 CONVEYOR SCALES

**Merrick Scale Mfg. Co.**—Bulletin 851 describes control of remote equipment by means of an automatic conveyor scale. Bulletin covers electrical, mechanical and pneumatic regulation of remote tie-in equipment as well as liquid-solid proportioning.

### 375 HYDRAULIC PUMPING

**Lufkin Foundry & Machine Co.**—Bulletin H-2 covers descriptions and specifications of hydraulic long-stroke pumping units for oil well applications.

### 376 PUNCHES AND DIES

**T. H. Lewthwaite Machine Co.**—New, revised catalog sheets list the range of metal-working punches and dies carried in stock for immediate shipment. Styles to fit most makes of hand-, foot-, and power-operated punch presses are standard. Hand-operated punches, cutters, and benders are also illustrated and described.

### 377 INDUSTRIAL WHEEL

**Roll-Rite Corp.**—Bulletin 302 illustrates and describes a new wheel which utilizes a molded rubber tread bonded vertically between two steel disks. By compressing the disks, a displaced and inflated tread is provided to support heavy loads in industrial materials handling applications.

### 378 PLANT CLEANING GUIDE

**Oakite Products, Inc.**—Booklet F9394 incorporates charts of equipment, cleaning methods, solutions, concentrations, temperatures, cleaning equipment. It covers cleaning, descaling, derusting, paint stripping, rust prevention, sanitizing, treatment of water in humidifying, air conditioning, refrigerating units. Steam and hot spray cleaning devices are described.

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### 379 CLAMPS, WASHERS

**Eaton Mfg. Co.**—A 28-page bulletin illustrates and gives specifications of terminal clamps, keps, reliance rings, spring lock washers, hose fasteners, and other types of fasteners.

### 380 PUSH-PULL CONTROL

**Controlex Corp. of America**—Four-page bulletin describes precision built push-pull control consisting of a solid, flexible stainless steel blade moving between rows of stainless steel balls and housed in a flexible tubing.

### 381 PRESSURE TRANSDUCER

**Pace Engineering Co.**—A data sheet describes magnetic reluctance transducer for gage or differential pressure measurement. Specifications of accuracy, sensitivity, dynamic response, and environment are given along with a discussion of operating principles. Auxiliary equipment for recording and control applications is also described.

### 382 PHOTOCOPY MACHINE

**Remington Rand**—Booklet P-401 gives detailed information on a machine which makes photocopies of office records in one minute without developing, washing, fixing or drying.

### 383 AUTOMATIC FILTERS

**R. P. Adams Co.**—Automatic filter for complete industrial automation is covered in new three-color bulletin. Dimension charts of three sizes, and flow graphs covering capacity with Poro-Stone, Poro-Screen and Poro-Edge elements given. Four-color operation drawings given. Current installation photographs shown.

### 384 ENGINEER'S HANDBOOK

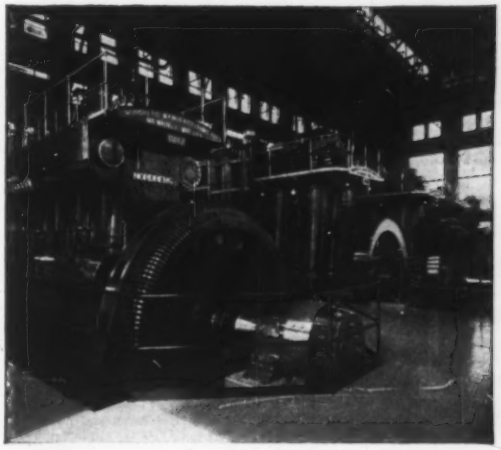
**Chase Brass & Copper Co.**—Catalog is designed as an aid in the laying out of hot and cold water lines, radiant heating and soil, waste and vent lines systems. It contains roughing-in drawings and dimensions for the complete line of cast, wrought and drainage solder-joint fittings. Data on copper water tube including flow charts, flow capacities, friction loss is listed along with architectural specifications, soldering information and copper drainage tube information.

### 385 AIR CYLINDERS

**Westinghouse Air Brake Co.**—A 12-page catalog describes and illustrates a line of single and double acting air cylinders in sizes of $1^1/_2$ in. dia. through $10^1/_2$ in. dia.


# WORN Cylinders?

# SCORED Cylinders?



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## is the answer.

- **Reclaim the bores of worn or scored power cylinder liners with wear resistant PORUS-KROME.**
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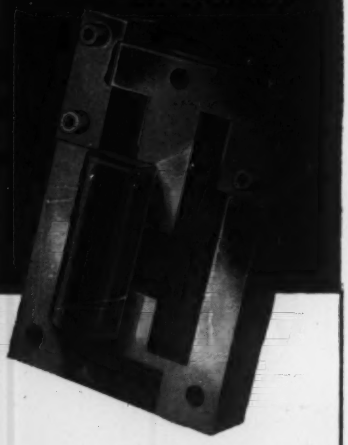

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1. *Made in Push and Pull types—within sizes ranging from 2½ to 21 lbs. at ½-inch stroke—to 2 to 25 lbs. at 1-inch stroke.*
2. *Rugged enough for the heaviest type of duty.*
3. *Compact—especially suited for limited space service.*
4. *Non-magnetic retainers.*
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Electrical Manufacturing Division

National Acme

The National Acme Company

192 East 131st Street, Cleveland 8, Ohio

YOUR *New Catalogs* GUIDE

**386** OIL AND GAS BOILERS

**S. T. Johnson Co., Mears, Kane, Ofeldt, Inc. Div.**—Bulletins 2-K, 6-H, 7-D and 4-H cover line of gas, oil and combination oil and gas fired boilers from 1 to 30 hp, with the necessary automatic boiler feeds.

**387** FIRE PROTECTION

**Blaw-Knox Co.**—Bulletin 2426 illustrates and describes a new spray sprinkler designed to reduce fire insurance costs by 50 to 90 per cent. Application, design and layout data on fire fighting systems is included.

**388** BOILER SERVICE VALVES

**Everlasting Valve Co.**—Bulletin describes the Everlasting Quick-Opening and Slow-Opening Straightway Valves, Angle Valves, Y Valves, and Duplex Blow-Off Units, with specifications, materials of construction, and dimensions of each type. Illustrations include details of design, sectional and exploded views, and explanations of operation of the valves. A section of the bulletin also describes Everlasting Valves for fire protection.

**389** OIL HEATING BOILER

**National U. S. Radiator Corp., Heating & Air Conditioning Div.**—The Premier oil heating boiler is featured in a 4-page catalog, Form 831. The unit is described as a wet base cast iron boiler of the 25B series, made to meet the heating and domestic hot water requirements of from large residential to small commercial installations.

**390** SUPER REFRACTORIES

**Carborundum Co., Refractories Div.**—"Properties of Super Refractories," twenty-four pages, covers latest data on super refractories including newly developed compositions for specialized applications. Re-frax silicon-nitride bonded silicon carbide refractories which can be produced in intricately designed shapes to close dimensional tolerances is described. Chemical analysis and physical property charts are provided on all materials.

**391** MOTION CONTROL

**General Tire, Industrial Products Div.**—Catalog No. 701 illustrates and describes instrument mounts, machinery mounts, bearings, bushings and special types of mounts for eliminating shock, vibration, oscillation, misalignment, noise. Specification tables and diagrams of various types are included.

**392** OPTICAL COMPARATORS

**Jones & Lamson Machine Co.**—Catalog No. 402-C illustrates and describes optical comparators. Typical applications are covered, and diagrams show the principles of construction and operation of the various units.

**393** SEAMLESS PIPE

**Babcock & Wilcox Co., Tubular Products Div.**—A 46-page pocket-sized manual covers the methods of working seamless tubes and pipe made of the firm's intermediate Croloys. Sections in the booklet include nominal composition, general characteristics, annealing practice, methods of working, welding and condensed technical data.

**394** GEAR PRODUCTION EQUIPMENT

**Fellows Gear Shaper Co.**—General catalog of 20 pages and 50 illustrations describes and gives specifications for machines for cutting and finishing gears, and instruments for gear inspection. Information on special attachments, gear shaper cutters, and shaving tools is included.

**395** AUTOMATIC BAR MACHINE

**National Acme Co.**—A 10-page Catalog illustrates and describes the new Model M single spindle automatic bar machine, a universal, fully automatic metalturning lathe which can sustain fine tolerances at the fastest speed that tungsten carbide and high speed tools can be safely operated.

**396** AIR DRILL HOSE

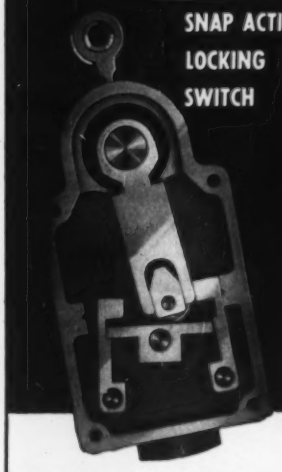
**Hewitt Rubber Div., Hewitt-Robins, Inc.**—Bulletin S-104 illustrates and describes air, air drill and general service hose. Included are cross sections and specifications of the various types.

NATIONAL ACME

SNAP-LOCK

TRADE MARK

THE ORIGINAL SNAP ACTION LOCKING SWITCH



**All National Acme Switches—Limit, Push Button, or Motor Starter Switches employ the same dependable, basic, SNAP-LOCK design. As illustrated above, the snap-action locking mechanism is simple, fool-proof and long-lived. Self-wiping, coin-silver contacts insure quick action make and break—with maximum wear resistance. For AC or DC service.**

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*Limit Switches*

Made in both single-pole and double-pole series, and with a wide variety of standard operating levers. Also made in push-lever type and with explosion-resistant housing.

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Made in heavy-duty, flush or surface-mounted types.

*Motor Starter*

Designed for 3-phase motors to 7½ HP on AC; ½ HP on DC.

FOR COMPLETE DETAILS send for Bulletin EM-51

Electrical Manufacturing Division

National Acme

THE NATIONAL ACME COMPANY

192 East 131st Street, Cleveland 8, Ohio

YOUR

## *New Catalogs*

GUIDE

**397 CONTOUR MEASURING**

**Bausch & Lomb**—A catalog illustrates and describes a contour measuring projector for industrial measurement, comparison and inspection. Diagrams showing how the unit operates are included.

**398 FLUSH LATCHES**

**Hartwell Co.**—A 44-page catalog describes firm's background and facilities and applications and materials specifications of flush latches and hinges. Diagrams show the various models and installations.

**399 STEAM GENERATORS**

**Union Iron Works**—Literature describes line of water tube steam generators from packaged type units for oil and gas fuels or shop assembled coal fired units to field erected water tube steam generators burning all commercial fuels, superheaters, economizers, air heaters, waste heat boilers and other auxiliaries; many illustrations included.

**400 PHOTOELASTIC POLARISCOPE**

**Polarizing Instrument Co.**—A catalog describes four new polariscopes and two straining frames for using polaroid light control in industry.

**401 SLITTING LINES**

**Yoder Co.**—A 76-page booklet provides basic information on design, selection and operations of slitters and slitting lines, including time studies and analysis of operating cycle, discussion of coil handling and scrap disposal methods. Specifications and capacity tables on the firm's uncoilers, slitters, recoilers, coil cars and scrap choppers are included.

**402 GEARS, GEAR ASSEMBLIES**

**Advance Gear & Machine Corp.**—Catalog illustrates and explains various types of gear cutting done as well as a representative group of special gears and gear assemblies produced. All types of custom gear cutting and gear assemblies to customers' specifications as well as many assemblies of their own design are offered by the company.

**403 STEEL FABRICATION**

**Crucible Steel Co. of America**—A 162-page fabricator's handbook covers forming, machining, cutting, joining, heat treating and pickling and finishing of stainless steels. Technical details are tabled in a special section with other reference data.

**404 MULTIPORT VALVE**

**Hungerford & Terry, Inc.**—A 16-page bulletin contains information and photographs of a poppet type multiport valve designed to operate water filters, zeolite water softeners, demineralizing equipment and other water conditioning equipment. The units work manually, semi-automatically or fully automatically.

**405 CHROMIUM**

**Van der Horst Corp.**—A 12-page illustrated brochure describes Porús-Krome, a porous, hard, wear and corrosion resistant chromium designed to increase life of internal combustion engine cylinders and compressor cylinders. Process is used for new equipment and reclamation of power cylinders in the marine, aviation, railroad and oil and gas industry.

**406 CURRENT COLLECTORS**

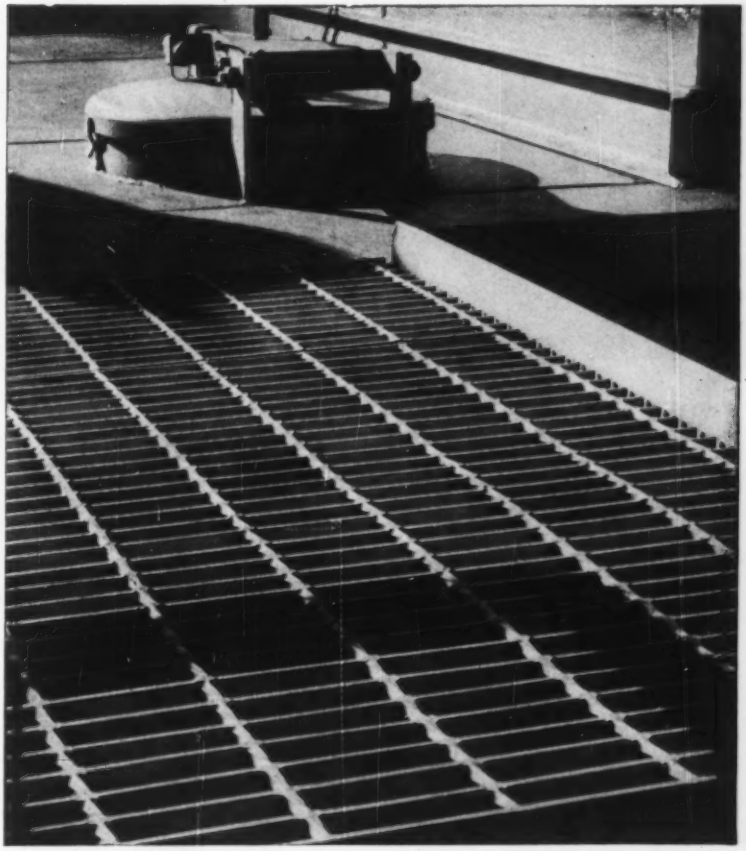
**Morganite, Inc.**—A 4-page folder illustrates and describes carbon current collectors. Three main types are shown for crane applications.

**407 POLYVINYL PRODUCTS**

**B. F. Goodrich Chemical Co.**—A booklet gives properties and illustrates applications of Geon vinyl resins for industrial and consumer uses in extrusions, film and sheeting, molded products, expanded vinyls, coatings and rigid materials.

**408 GAGES**

**Manning, Maxwell & Moore, Inc.**—A 128-page catalog describes the company's line of Duragages, quality, drawn case, chemical, chemical attachments, special application, navy and marine, laboratory and pocket test, Mercury column pressure and vacuum gages.

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**Let the Chromalox Sales-Engineering staff solve your heating problems . . . electrically**

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Contains information on complete line of Chromalox Electric Heaters, elements, thermostats, contactors and switches. Gives uses, construction information and prices, plus basic heat calculation data and heat loss charts.

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A-4447A

YOUR

# New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

### 409 ELECTRICAL HEATING UNITS

**Edwin L. Wiegand Co.**—Booklet illustrating and describing 101 ways to apply electric heat and showing approved methods of electrically heating liquids, air, gases, machine parts and process equipment. All items are illustrated and described in detail and varied applications are shown. The heating units go under the trade name of chromolox.

### 410 FLEXIBLE SEAL

**New Departure Div., General Motors Corp.**—A folder illustrates and describes the sentriseal, a new type of flexible seal available on a large variety of standard dimension ball bearings. This seal, which is available on a series of adapter bearings makes it possible to relubricate where desired, without removing the seals. Seals are easily removed if required.

### 411 STEEL RESERVOIRS

**L. O. Koven & Brother, Inc.**—Bulletin No. 555 illustrates and describes steel reservoirs and standpipes for water storage from 50,000 to 2,500,000 gal for municipal and private water distribution systems. Representative sizes are listed.

### 412 DRAWING PENCIL

**American Lead Pencil Co.**—A technical test kit with 2 Venus drawing pencils is offered free. Lead is homogenized under the patented colloidal process to assure smoothness, no scratching, no hard spots, no soft spots.

### 413 VALVES

**Ledeen Mfg. Co.**—A 16-page bulletin illustrates and describes the company's line of hand, foot, power and solenoid operated valves, air, oil, gas or water powered. Bulletin gives operating and flow cycles, dimensions and weights. Circuit diagrams, parts and accessories are included.

### 414 FUEL CELL FASTENER

**Waldes Kohinoor, Inc.**—A 7-page catalog provides engineering data and specifications for the company's Waldes positive lock fastener, which is used to hold airplane fuel cells in place without piercing the cell wall on installation. Illustrations and charts explain the use and method of application for the device.

### 415 PNEUMATIC INSTRUMENTS

**U.S. Gauge Div., American Machine & Metals, Inc.**—A 16-page catalog, No. 505, discusses indicating pilots, transmitters and receiver gages for process control. A new instrument shown for the first time is a $3^1/_2$ in. scanning diaphragm receiving gage with rotatable dial to enable the operator to rotate the dial to a common set point.

### 416 HEATERS

**Dravo Corp.**—Bulletin 523-B and 552 cover the firm's forced air space heaters for comfort heating, year-round ventilating, tempering make-up air, process drying, heat curing. The units are direct fired by oil, gas or combination fuels.

### 417 DIESEL LUBRICATION

**Shell Oil Co.**—An 8-page booklet describes Rimula oil, which meets the requirements of Caterpillar Co. Series 3 diesel lubricating oil. Other applications in the gasoline engine field are described.

### 418 PRESSURE REDUCING VALVES

**Spence Engineering Co.**—A four-page bulletin describes two models of direct-operated water pressure reducing valves for dead-end water service where flow is intermittent and subject to abrupt fluctuation. Pressures range from 30–80 psi and 10–50 psi.

### 419 SERVOMECHANISM GEAR BOX

**Link Aviation, Inc.**—An 8-page bulletin describes the Link Hi-Precision gear box, designed for use in quality computer, servomechanism and testing equipment. Adapters and couplings are also described. The gear box is availble in ratios from 10:1 to 3125:1. Size is $3^1/_2 \times 3^1/_2 \times 2^7/_{32}$ in., for all ratios.

### 420 MARINE PANEL

**Philip Carey Mfg. Co.**—A folder describes a combination insulation and structural wall panel for ship bulkheads and industrial plants. The panel has a laminated core of corrugated and flat asbestos paper, surfaced on both sides with asbestos-cement board.

### 421 CONDENSER, HEAT EXCHANGER

**Bridgeport Brass Co.**—A 162-page illustrated handbook covers copper alloy tubes for condensers, heat exchangers, evaporators and general piping used in power plants, ships, oil refineries, chemical and petrochemical plants and process industries.

### 422 STREAMLINED BAFFLES

**Engineer Co.**—Bulletin BW-54 shows the design and describes the construction of streamlined baffles for many types of water tube boilers for various furnace designs and methods of firing.

### 423 CONDENSATE RETURN UNITS

**Ingersoll-Rand Co.**—Complete condensate return units to suit any conditions are described in Form 7188. The package-type units have motor-pumps in a wide range of sizes. Either vertical or horizontal tank mounting is available.

### 424 REVOLVING UNIT HEATERS

**L. J. Wing Mfg. Co.**—Bulletin HR-6A describes revolving unit heaters which feature a revolving air-distributor with one or more outlets. Models are available for steam, hot water, and electric and gas heat supply in a full range of sizes. Also can be used for summer cooling. Design and construction details are included.

### 425 PRESSURE REDUCING VALVES

**C. E. Squires Co.**—A four-page bulletin illustrates and describes the following types of valves: pressure reducing, temperature regulating, combined pressure and temperature regulating, boiler feed water controllers, pump governor, pilot valves.

### 426 PRESSURE GAGES

**Norden-Ketay Corp., Instrument and Systems Div.**—Four-page bulletin No. 364 has specifications of the Acragage series of gages for measurement of pressure and vacuum. Gages are offered in flush and surface mounting in ranges from 0–15 to 0–20,000 psi.

### 427 SELF-ALIGNING COUPLINGS

**Koppers Company, Inc., Metal Products Div.**—A 6-page folder illustrates and describes principles and features of Fast's self-aligning couplings. A table of utility factors for various kinds of connected machines and tables of rating for standard forged-steel and heavy-duty couplings are included.

### 428 INSTRUMENTS

**Consolidated Electrodynamics Corp.**—A 12-page general catalog describes data processing instruments and systems for automatic measurement and recording of physical variables, such as pressure, vibration, acceleration, stress, strain and temperature. Systems are designed to record up to 50 high-speed physical variables simultaneously. All instruments are described briefly and specific technical bulletins are listed on each.

### 429 TECHNICAL BOOKS FOR ENGINEERS

**Ronald Press Co.**—Brochures containing detailed descriptions of current technical books on mechanics, engineering, aeronautics, industrial management, metallurgy, applied and physical sciences, etc. Practical reference works like the Ronald Handbooks, basic studies, and pioneering works on the latest engineering and scientific developments are included.

### 430 O-RINGS

**National Seal Div., Federal-Mogul-Bower Bearings, Inc.**—This National O-Ring Catalog is designed for broadest usefulness in all types of O-ring applications. Includes practical working information about O-ring applications, sizes, groove dimensions, back-up rings, and dust seals, and lists all National O-Rings and local National Motor Bearing offices.

ENGINEERS
*Mechanical & Electromechanical*

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*To: Professional Staff Appointments*

**The Johns Hopkins University Applied Physics Laboratory**

**8607 Georgia Avenue, Silver Spring, Md.**

YOUR *New Catalogs* GUIDE

**431 DEAERATION**

**Cochrane Corp.**—Publication No. 4650 explains in capsule form the fundamentals of deaeration and why it is necessary in water conditioning. The principles of operation as well as the advantages and application of the various methods of deaeration are discussed.

**432 PRESSURE GAGES**

**American Chain & Cable Co., Helicoid Gage Div.**—The 24-page Helicoid gage catalog describes the Helicoid gage as guaranteed accurate to within $\frac{1}{2}$ of 1 per cent of the total dial graduation over the upper 95 per cent of the 270-deg dial arc. Cutaway photographs and line drawings show the complete line of Helicoid gages.

**433 REFRACTORIES**

**Norton Co.**—A 32-page instructional manual illustrates and describes the application and suggested uses of Crystolon silicon carbide refractories in boilers. Included are curves of thermal conductivity and air flow through air cooled walls.

**434 PNEUMATIC MARKERS**

**Pannier Corp.**—A data sheet illustrates and describes single stroke pneumatic markers for hot metal stamping. Photos, specifications and a discussion on the features of the units are included in the bulletin, designated C-14.

**435 ANALOG COMPUTING COMPONENTS**

**George A. Philbrick Researches, Inc.**—A 16-page Catalog covers line of electronic analog computing components. It graphically demonstrates the use of the modular concept in building a computor installation.

**436 FORGINGS**

**United States Steel Corp.**—A booklet illustrates and describes the manufacture and application of generator, turbine and waterwheel forgings, anvil bases and columns, forged shafts, forged steel rolls and sleeves, forged blooms, billets and rounds, and miscellaneous forgings. A history of forging is included in the booklet.

**437 FILTERS, FILTER ELEMENTS**

**Cuno Engineering Corp.**—Catalogs cover Micro-Klean replaceable filter elements, of Flo-Klean automatic self-cleaning wire-wound filters, Poro-Klean porous stainless steel media for filtration, and Micro-Klean filters for air line service.

**438 BOILER CONTROLS**

**McDonnell & Miller, Inc.**—A Catalog describes boiler water level controls and safety devices. Product illustrations, brief descriptions, capacity curves, dimension details and service recommendations are included.

**439 MULTIPLIER PHOTOTUBES**

**Allen B. DuMont Laboratories**—Catalog No. 754-MP describes function and design theory of multiplier phototubes. Description and specification of 13 phototubes are included in these 64 pages.

**440 BRONZE, IRON VALVES**

**Wm. Powell Co.**—A 589-page, hard-cover general catalog covers bronze and iron valves for controlling steam, water, oil, gas, air, liquids and other media. In addition to photos and specifications of the valves, the book contains comprehensive engineering data and information and a section illustrating the firm's manufacturing and testing facilities.

**441 CASTING DESIGN**

**Meehanite Metal Corp.**—New 64-page Bulletin No. 44 contains data in easy-to-use form on how to design sound engineered castings. Of value to engineers, designers and users of castings. Included are 150 illustrations, diagrams and photographs.

**442 SURFACE CONDENSERS**

**Ross Heat Exchanger Div., American-Standard**—Companion bulletins for power plants are offered. No. 8.2K1 contains design data, specifications and application photos on twin-bank balanced flow surface condensers; No. 5.6K1 describes unique high pressure closure used on feedwater heaters and other high pressure, high temperature exchangers.

**PRICE is a RESULT not a point of DEPARTURE**

*Anthony J. Lucas*

METHODS MGR., THE CINCINNATI GEAR CO.

My department is called "Methods," but it actually covers a lot more ground than the title would indicate to the average person. Methods' task is to carefully plan each job that is to go through our plant . . . lay out the operations required, in order and through the various machines indicated for that particular job . . . choose the correct material, in the correct form, and the type of blank for the job . . . determine the type of heat treating or finishing required . . . estimate the time involved for each operation, the cost of each ingredient in the manufacturing process.

After all this is completed, and *only* after it is all completed, then we give our Sales Representative a price to quote to you the customer. All this must be done before we have any assurance that your order will be placed with us.

We never "guesstimate" a price; and once we receive your order, we are not compelled to resort to juggling to make the final price come out like the quote. It is my responsibility to make certain that our quote will reflect the *actual cost* of what we feel will be the right gear for the job—made of materials and by a sequence of operations that will produce for your particular application the *gear of lowest ultimate cost.*

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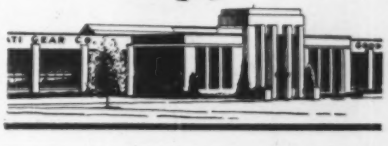
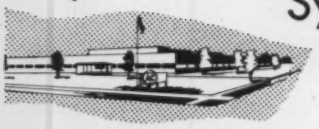


# Servo Engineers

## ELECTRICAL MECHANICAL

Inertial Guidance System Program



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Work with the top men in the field and with the finest test, research and development facilities. New plant being added in suburban Milwaukee as a part of Major, Permanent, Expansion Program.

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(In Suburban San Fernando Valley, Los Angeles)


YOUR *New Catalogs* GUIDE

**443 MECHANICAL DESIGN**

**Arthur D. Little, Inc.**—A brochure covers creative design, basic engineering studies and analyses, product and equipment engineering and development, equipment development for heating and air conditioning, automation studies, cryogenic engineering and equipment for helium, hydrogen, nitrogen, and oxygen, economic evaluations of production processes and methods, and basic scientific research equipment.

**444 DATA SYSTEM**

**Beckman Instruments, Inc. Scientific Instruments Div.,**—A 16-page brochure illustrates and describes Model 111 data system, a unit used as a link between sensing elements and computer in chemical processing industries. Other applications include pilot plants, weather logging, atomic reactor monitoring, testing.

**445 STEAM GENERATING EQUIPMENT**

**Combustion Engineering, Inc.**—A 20-page brochure describes and illustrates the facilities, products and installations of this company's fuel burning, steam generating and related equipment. Individual catalogs of most of the equipment mentioned are available.

**446 LEAD TREATED STEEL**

**Copperweld Steel Co., Steel Div.**—An 8-page bulletin illustrates and describes lead treated steels. Production advantages are listed, along with case histories, application data and tables of properties.

**447 MANUAL CHUCKS**

**Cushman Chuck Co.**—Catalog No. 66-1956 contains pricing information of a range of independent self-centering, combination and collet chucks. Engineering data is included, along with information on special chucks for special tooling, power wrenches and new Accra-set and compensating chucks.

**448 TANKS, TOWERS**

**W. E. Caldwell Co.**—General Catalog No. 65 lists sizes and types of steel tanks and towers and wood tanks. Capacity chart, illustrations, technical and price data on elevated tanks for fire protection, industrial and municipal installations are included.

**449 GASKET MATERIAL**

**American Felt Co.**—Literature describes the chemical and physical properties of Vistex with Teflon, a gasketing material. It has a tensile strength of 5000 psi, good cutting properties and is designed to resist fraying.

**450 BRONZE GLOBE VALVES**

**Lunkenheimer Co.**—A 4-page circular illustrates and describes two pressure classes of LQ600 bronze globe valves for a variety of services from normal to exceptionally severe. ASTM, ASME and military specification numbers of the firm's alloy for bodies and bonnets are included.

**451 MECHANICAL DIFFERENTIALS**

**Ford Instrument Div., Sperry Rand Corp.**—A 6-page brochure covers a line of mechanical differentials for control and analog computer applications. They are offered in sizes from $^1/_8$ to $^1/_{16}$ in. shaft diameters.

**452 FIELD COUPLINGS**

**Dynamatic Div., Eaton Mfg. Co.**—Bulletin SF-3 describes liquid cooled stationary field couplings. Construction and operation details, torque characteristics, efficiency, cooling and application data are included.

**453 HIGH-PRESSURE VALVES**

**Yarnall-Waring Co.**—A bulletin illustrates and describes Welbond valves for high pressure, high temperature service. They are recommended for general boiler room use including drain service on water wall headers, economizers, water columns and gages, drain and vent services on superheaters and steam lines, shut-off service on sampling lines, by-passes, water gages, columns and instruments.

**454 PUMP, TANK UNIT**

**Ruthman Machinery Co.**—Literature describes pump and tank unit No. 4072-T for handling abra-

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sive materials such as silicon carbide solutions on honing, lapping and ultrasonic machines. The tank is available in all stainless steel or standard carbon steel.

### 455 BELT FEEDER

**Omega Machine Co.**—Bulletin 35-N16 covers the firm's Model 37 belt gravimetric feeder for continuously weighing and feeding dry materials at high rates. The unit has a feed rate of 3000 lb per min and an accuracy of ±1 per cent by weight within range.

### 456 PACKINGS, GASKETS

**Crane Packing Co.**—A 12-page booklet illustrates and describes the firm's Teflon mechanical and hydraulic packings, sheets, rods, tubing, tape, flexible bellows, gaskets, custom molded and machine parts, electrical and electronic parts.

### 457 SPEED REDUCERS

**Farrel-Birmingham Co.**—A 52-page bulletin, No. 450, contains information on the firm's re-engineered, repeated, and expanded line of speed reducers. Included are horsepower rating tables, specifications, dimensions, weights and other selection and application data.

### 458 INDUSTRIAL PUMPS

**Nagle Pumps, Inc.**—Catalog No. 5206 covers centrifugal pumps for use in beet sugar refining, ceramic industry, chemical and process industries, coal mining and preparation, gravel pits and quarries, metal working industries, ore mining and preparation, paper mills, petroleum industry, power plants, sewage treatment plants and water works, steel mills, blast furnaces and foundries. Various types of horizontal and vertical pumps are illustrated. Specifications, diagrams and construction details ard included.

### 459 WATER COLUMNS, GAGES

**Ernst Water Column & Gage Co.**—Bulletin 8-1-56 illustrates and gives specifications of bronze gages, flow indicators, water columns, steel gages and valves, gage glasses and gaskets.

### 460 REPRODUCTION MATERIALS

**Eastman Kodak Co.**—All materials available for preparation and reproduction of drawings and documents are described in a booklet. A materials selection chart which matches originals to be reproduced with the equipment is included.

### 461 CYLINDERS

**Ledeen Mfg. Co.**—A 12-page bulletin illustrates and describes the company's line of cylinders for air, oil, water, gas or steam operation in medium, heavy and super-duty construction. Selection information, ratings and limitations, and rod and head attachments are included.

### 462 MINIATURE BALL BEARINGS

**New Hampshire Ball Bearings, Inc.**—A catalog features an article on factors to consider in selecting miniature bearings. Tables are laid out by bore size. Ordering instructions and explanation of symbols are included along with engineering bulletins giving technical details. Short form catalog gives quick identification of standard bearings.

### 463 PULSE TRAPS

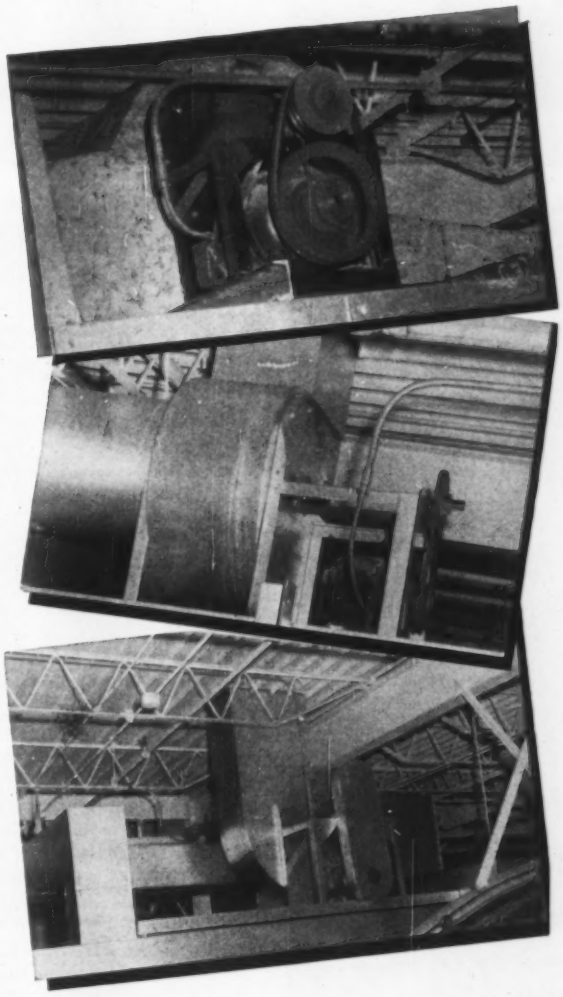
**Everett & Everett Engineers**—A bulletin covers application, performance and dimensional data on pulse traps for drilling, oil well pumping, gasoline plants, refineries, pipe lines, boiler feed pumps, reciprocating steam pumps, power plants, sewage treatment plants, compressors and engines.

### 464 DIAPHRAGM VALVES

**Hills-McCanna Co.**—A 12-page catalog, No. 100, describes diaphragm valves in terms of their advantages, applications and specifications. The three basic types of valve operations are shown and dimensional specifications are given. Information is also included on plastic bodies.

### 465 INDUSTRIAL COOLING FANS

**Koppers Company, Inc., Metal Products Div.**—A 4-page folder illustrates and describes new, all-metal Aeromaster fans for cooling towers and radiator-type coolers. Design features are discussed. A 4-page folder on precision-engineered air delivery is also available.

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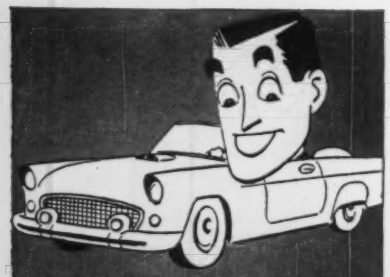

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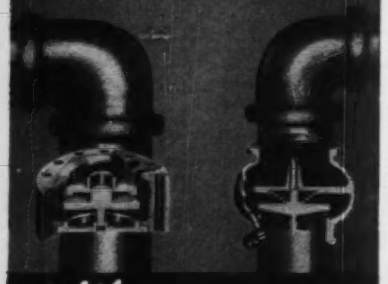

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**466 RECORDING SYSTEMS**

**Brush Electronics Co.**—A 6-page folder, ED 21720, describes instruments for modern measurements. Various oscillographs and amplifiers are cataloged, along with accessories and supplies for recording systems.

**467 RIGID METALS**

**Rigidized Metal Corp.**—A 30-page booklet illustrates and describes Rigid-tex metal properties, application case histories, colorized and pattern combination effects, fabricating, purchasing and finishing.

**468 FORGED STEEL VALVES**

**Ohio Injector Co.**—A bulletin illustrates and describes two new forged steel gate lines, 1100 series high flow and 1300 series high flow. An exploded view shows component parts. Trim and pressure-temperature charts are included.

**469 CENTRIFUGAL PUMPS**

**Dean Bros. Pumps Inc.**—Circular No. 190 illustrates Type GS standard centrifugal pumps for general and chemical service. Design and construction data is givea, along with a sectional view and parts list and dimension prints of the various units in the series.

**470 DIFFERENTIAL PRESSURE TRANSMITTER**

**Taylor Instrument Cos.**—Bulletin 98274 illustrates and describes differential pressure transmitter, 200TD111, for measurement of flow, liquid level, pressure or density of fluids.

**471 CENTRIFUGAL FANS**

**Buffalo Forge Co.**—Bulletin FD106 covers design, performance and application data on backward curved blade centrifugal fans. Dimensions are tabled.

**472 VALVES, CONTROLS**

**Hays Mfg. Co.**—A packet of data sheets covers the firm's lines of solenoid valves, controls, strainers and automatic interlocks. Specifications, dimensions and flow charts are given.

**473 O-RINGS**

**Precision Rubber Products Corp.**—A 52-page handbook covers O-rings and Dynaseal packings. Included is data on the company's facilities, non-moving and moving seals, military approved O-rings, compounds, back-up rings, and seals and rings for a variety of applications.

**474 AUTOMATION DRIVES**

**Reliance Electric & Engineering Co.**—Bulletin A-1555-B illustrates and describes variable speed drives, motors, generators, gearmotors and controls for aiding automation in industry.

**475 VULCANIZED FIBER**

**Spaulding Fibre Co.**—A catalog details general physical properties and specific uses for vulcanized fiber products for industry. Engineering reference data and illustrations of applications and products are included.

**476 CAST IRON SPECIFICATIONS**

**Gray Iron Founders' Society**—A 4-page chart covers commonly used specifications for ductile cast irons, giving properties, chemical composition and typical applications. Included are specifications for cast pressure pipe, soil pipe, valves and fittings. Standards, methods of testing, recommended practice and definitions are also listed.

**477 MINIATURE COUPLINGS**

**Thomas Flexible Coupling Co.**—Bulletin Mc-100 illustrates and gives specifications of miniature coupligns for power transmission. The units are capable of speeds to 50,000 rpm for holding synchronism, relieving bearing loads, holding constant torque and handling parallel and angular misalignment.

**478 CAST STEEL VALVES**

**Wm. Powell Co.**—A 209-page catalog, No. 102, covers cast steel bolted flanged bonnet valves, class 150 lb to class 2500 lb, and pressure seal valves, classes 600, 900, 1500, 2500 lb and higher. An additional 48-page supplement contains extracts from ASA standards for steel pipe flanges and flanged fittings, including reference to valves.

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**479 STEAM HEAT CONTROLLER**

**C.E. Squires Co.**—A bulletin illustrates and describes the firm's slow opening, fast close steam heat controller, Valvatrol. Basic design features of the unit include adjustable rate of slow opening; fast, positive closing (absolute dead end); accurate pressure reduction; control of heat and process steam supply.

**480 SPEED REDUCERS**

**Winsmith, Inc.**—Catalog 155, 112 pages, covers more than 150 models, including the recently introduced "C" series. It contains engineering selection data and is sectionalized for quick and easy reference to all information. A special general engineering section is included to aid in solving application problems.

**481 VALVES**

**Republic Mfg. Co.**—Catalog No. 654A, 72 pages, illustrates and gives specifications on needle, globe, plug, check, relief, selector valves for industrial, chemical and aviation uses.

**482 AUTOMATIC CONTROL**

**Hagan Corp.**—Bulletin MSP-133 illustrates and describes the firm's facilities and products for automatic control for aerodynamic research and testing. Included are specifications on transducers, amplifiers, converters, controllers, power supplies, point stations, signal generators, feedback potentiometers, signal shapers, positioners, computers.

**483 LOCKING RING**

**Rosan Inc.**—A catalog illustrates and describes a locking ring for inserts and studs. The principle of the unit's operation is described, and specifications of locks, inserts, studs and screws are included in the 42-page booklet.

**484 CERAMIC COATINGS**

**Solar Aircraft Co.**—A bulletin illustrates and describes a family of proprietary ceramic coatings specially designed to protect high or low alloy steel fabrications from heat or corrosion. Sections of the 8-page bulletin deal with the use of ceramic coatings, properties and application data.

**485 ANALOG-DIGITAL CONVERTER**

**Librascope, Inc.**—A six-page folder shows specifications and illustrations of converters which transfer data from shaft to code disks where nonambiguous double brush pick-offs direct it to scan a network. Models cover 7 to 19 digits.

**486 TECHNICAL BOOKS**

**The American Society of Mechanical Engineers**—1957 Catalog of ASME Publications is a 20-page descriptive price list of current books, standards, codes, research reports, and periodicals published by the Society.

**487 RESILIENT FRICTION MATERIALS**

**Armstrong Cork Co.**—A booklet illustrates and describes cork facings used in a variety of wet and dry clutch applications. Included are statements about temperatures, pressures and other factors in the range in which resilient cork friction compounds are used.

**488 DEMINERALIZING**

**Cochrane Corp.**—Publication 5800 describes the demineralizing process and various application in efficient removal of silica. Flow diagrams and photos of various types of installations are included.

**489 CLAD STEEL EQUIPMENT**

**Lukens Steel Co.**—A 28-page booklet covers the development, manufacture and properties of clad steels, the types of cladding materials available, design considerations, fabrication techniques and clad steel equipment applications.

**490 BUILDING DRAINAGE CONTROL**

**J. A. Zurn Mfg. Div., Zurn Industries, Inc.**—Bulletin 56-1 covers systems for wall-type plumbing fixtures, roof drains, floor drains, interceptors, cleanouts, high and low pressure hydrants, swimming pool equipment, pipe line strainers.


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**491 PIPING DESIGN**

**Blaw-Knox Co., Power Piping and Sprinkler Div.**—The design of piping for flexibility with Flex-Anal Charts is covered in an 86-page book. It fills the need for the flexibility analysis of any piping system. It is intended for the experienced pipe designer who can, by use of this method and the application of Flex-Anal Charts, accurately analyze most piping systems in a few hours which formerly required days and even weeks. Many tables, Flex-Anal Charts, and typical piping layouts are included.

**492 NAMEPLATE MARKING**

**Jas. H. Matthews & Co.**—An eight-page bulletin illustrates and describes nameplate marking equipment from steel hand stamps to production machines.

**493 GRATING, STAIR TREADS**

**Dravo Corp., Machinery Div.**—Bulletin 1105 illustrates and describes aluminum, diagonal, radial, rectangular and serrated grating, stair treads, and special metals, fasteners, and construction of these units for industry. Selection and application information is included.

**494 ELECTRIC HEATING UNITS**

**Edwin L. Wiegand Co.**—Catalog 50 covers specifications, construction details, application data, and prices of their complete line of electric heating units. Models are available with strip, ring, tubular, and cartridge heating elements. Also described are immersion, circulation, radiant, and forced-air duct heaters. Charts and tables are provided.

**495 HIGH-STRENGTH STEEL**

**Jones & Laughlin Steel Corp.**—A booklet presents Jalten, a versatile low-alloy high-strength steel said to have light weight, abrasion and corrosion resistance and easy weldability. Application data is illustrated and described and tables show specifications.

**496 LIMIT SWITCHES**

**National Acme Co.**—Bulletin EM-51 covers the firm's line of heavy duty limit switches designed to meet severe mechanical and electrical conditions imposed by heavy duty machine tools. EM-5512 illustrates a new single pole, double make, double break snap-action series of switches and EM-5524 illustrates a double pole, double throw, quick make-quick break series.

**497 CRADLE-MOUNTED PUMPS**

**Ingersoll-Rand Co.**—Bulletin 7223-B describes CRV Class centrifugal pumps. These units have capacities from 5 to 2800 gpm with pressures of 10 to 525 ft total head. A concise tabulation or types and ratings, performance tables and dimensions are included.

**498 RETAINING RINGS**

**Waldes Kohinoor, Inc.**—A new 8-page catalog supplements the company's 52-page catalog covering Waldes Truare retaining rings. The two catalogs include 33 pages of engineering and specification charts, 6 pages of field applications and case histories, 20 pages devoted to Truare pliers, assembly, and accessory tools, and other relevant information pertaining to the most advantageous use and selection of the rings.

**499 ANALOG TO DIGITAL CONVERTER**

**Norden-Ketay Corp., Instrument and Systems Div.**—Four-page bulletin No. 372 has applications, characteristics and installation drawing of ADC-1A analog to digital converter. The converter described has an unambiguous output of 13 binary digits and operates at high speed in clockwise or counterclockwise operation.

**500 STEEL ANALYSES**

**Crucible Steel Co. of America**—A 62-page, pocket-sized book contains analysis tables of high speed, tool, stainless, alloy, machinery and special purpose steels.

**501 CENTER GUIDED CHECK VALVE**

**Miller Valve Co. Inc.**—An eight-page bulletin illustrates and describes the Streamflow center guided check valve, said to be silent and shockproof, and which can be installed vertically or horizontally. Specifications and dimensions are tabled.

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**502 BEARING BRONZE**

**Bearium Metals Corp.**—Three-color, 6-page folder describes the frictional properties available in Bearium Metal and illustrates typical bar stock sizes and individual castings. Photomicrographs show structure and lead distribution achieved in production of this metal, accounting for its advantages for bearings, bushings, thrust washers, and other requirements involving rubbing friction.

**503 CLEANABLE FILTERS**

**Cuno Engineering Corp.**—Literature covers Auto-Klean edge-type cleanable filters, and filters for built-in installations.

**504 INFRARED PACKAGE**

**Beckman Instruments, Inc., Scientific Instruments Div.**—A package of reprints contains scientific and engineering information on infrared spectroscopy. Also included is a bulletin on a new infrared spectrophotometer.

**505 GAS TURBINE ENGINE**

**Solar Aircraft Co.**—A bulletin describes the company's 50-hp Mars gas turbine engine which operates at approximately 40,000 rpm. The basic engine, including engine mounted equipment and gears to provide conventional output speeds, weighs less than 100 lb and is smaller than a 2-ft cube. It can be started by hand, electrically or mechanically and operates on a variety of fuels, including gasoline, jet engine fuels, diesel oil.

**506 POLYVINYL PIPE**

**National Tube Div., U.S. Steel Corp.**—Bulletin 24 gives properties and specifications of both high-impact and normal impact polyvinyl chloride pipe. A section covers installation procedures. The chemical resistance of the plastic pipe is compared with pipe of other materials.

**507 RADIAL FANS**

**Buffalo Forge Co.**—Bulletin FD205 illustrates and describes type CR radial blade type fans for industrial and power plant service. Performance characteristics, selection and dimension data are given.

**508 STATIC PRESSURE SEAL**

**Precision Rubber Products Corp.**—An 8-page bulletin gives engineering data on Dyna-Seal, a one-piece seal with an inner sealing ring of resilient deformable synthetic rubber bonded to an outer confining steel ring. It is designed for sealing under bolt heads and such abutment flanges as the pipe union.

**509 CORROSION RESISTANT VALVES**

**Wm. Powell Co.**—Catalog 253-A covers design, specifications, operations and application of corrosion resistant valves in stainless steel, nickel and nickel alloys, bronzes, alloy steels, cast irons, aluminum, silver, hard lead and molybdenum.

**510 ALUMINUM PIPE, FITTINGS**

**Aluminum Co. of America**—A 16-page booklet covers process piping, pipelines, portable piping, structural piping applications, fittings and flanges, installation, dimensions and weights of aluminum pipe and fittings.

**511 VARIABLE-SPEED DRIVE**

**Reliance Electric & Engineering Co.**—Bulletin D-2501 covers model VS-100 variable-speed drive, $^1/_3$ to 4 hp, 100:1 speed range, 0.1 per cent speedload regulation.

**512 ADJUSTABLE PIPE HANGERS**

**Blaw-Knox Co., Power Piping and Sprinkler Div.**—New 100-page Catalog 54 features the Blaw-Knox functional spring hangers, vibration eliminators, and overhead roller assemblies. The improving and simplifying of complicated piping systems is explained by charts and drawings. A Technical Section enables a piping engineer to solve most hanger load problems and thus determine the hanger requirements for the particular piping under consideration.

**513 VINYL VALVE**

**Lunkenheimer Co.**—A 6-page circular describes what is said to be the first all-molded corrosion-resistant PVC valve ever designed by a valve manufacturer. Installation data and dimensions are included.


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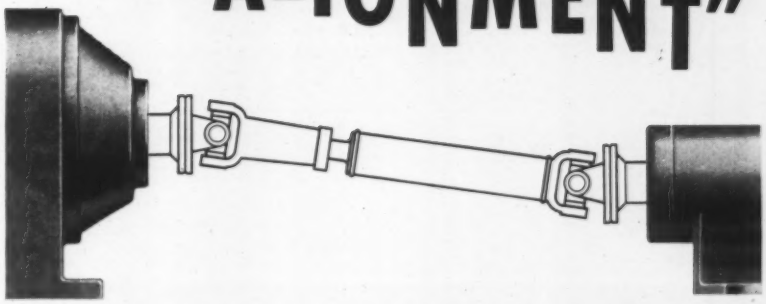

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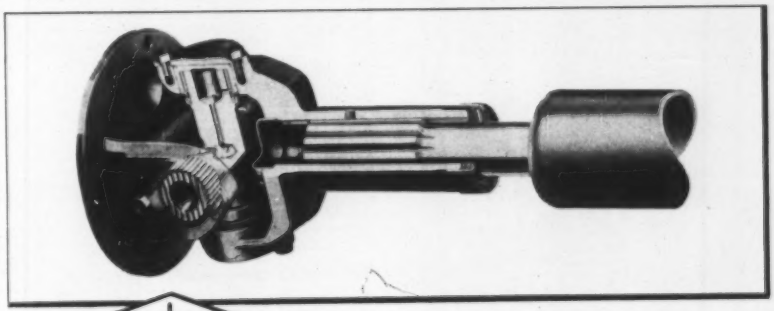

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Needle bearing universal joints compensate misalignment.
Splined connection permits end movement.
Tubular shaft permits high speed operation.
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Speeds to 4000 RPM.
Maximum angularity from 8° to 22°.
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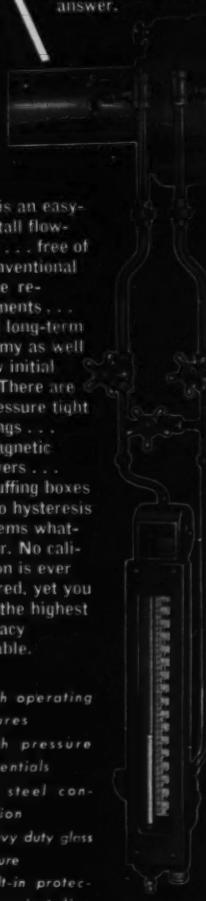

Here is an easy-to-install flowmeter . . . free of all conventional service requirements . . . giving long-term economy as well as low initial cost. There are no pressure tight bearings . . . no magnetic followers . . . no stuffing boxes . . . no hysteresis problems whatsoever. No calibration is ever required, yet you have the highest accuracy available.

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Write for Bulletin 18A

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YOUR *New Catalogs* GUIDE

**514 HIGH-STRENGTH STEELS**

**United States Steel Corp.**—A 174-page manual discusses the essential principles of structural design and contains numerous formulas, charts and tables to assist in designing, for high-strength steels. The hard cover, ring-bound book covers engineering considerations and fundamental characteristics of high-strength steels, design considerations, working unit stresses, tension, compression, shear, stresses in beams, deformation and deflection, formed sections and designing against corrosion.

**515 PACKLESS EXPANSION JOINTS**

**American Dist. Steam Div., Adsco Industries, Inc.**—Bulletin No. 35-51A illustrates and describes Corruflex packless expansion joints. Design and construction details, simplified selection data, installation data, dimension tables and typical piping arrangements are included.

**516 HUMIDITY CONDITIONING**

**Surface Combustion Corp.**—Literature describes chemical humidity conditioning—removing moisture from the air by absorbing it into a special salt solution. It is stated that the process removes bacteria to make the treated air germ-free.

**517 PROCESS INDUSTRIES**

**Aluminum Co. of America**—An 80-page booklet covers applications of aluminum in the petroleum, petrochemical, chemical, food and drug industries. Included is a service dictionary of performance of aluminum with chemicals, and a section of the design of process equipment.

**518 LUBRICATORS**

**Manzel Div., Houdaille Industries, Inc.**—A series of bulletins illustrates and describes force feed lubricators, spray lubricating systems, high pressure lubricators, pulsators, chemical feeders, a 10-ton bench or portable arbor press, and slurry pumps.

**519 AUTOMATIC CONTROLS**

**Photoswitch Div., Electronics Corp. of America**—Bulletin PA 561 illustrates and describes packaged photoelectric systems for industrial control application, including conveyor control, counting, inspecting and sorting, smoke detection and high-temperature measurement and control.

**520 FASTENERS**

**H. M. Harper Co.**—A 24-page booklet illustrates and describes Flo-Form corrosion resistant fastenings. Bolts, screws, pins, studs, wedges, U-bolts, nuts are shown with their alloys, characteristic industry and use. Primary and secondary operations in making the units, and a practical guide to the design of cold headed shapes are included.

**521 GEARMOTORS**

**Philadelphia Gear Wks., Inc.**—A 44-page catalog covers the design and selection of gearmotors, utility gearmotors, in-line reducers and right angle gearmotors. Information is given on unit type, capacity range, use, mounting positions, overhung load shaft capacities, dimensions and parts lists.

**522 HEAT EXCHANGERS**

**Alco Products, Inc.**—Bullein FH-3 illustrates and describes Alcotwin fin tube heat exchangers. Dimensions, mechanical specifications, and charts of finside coefficient and finside pressure drop for all sizes are included.

**523 OSCILLOSCOPES**

**Allen B. DuMont Laboratoies**—Catalog No. 754, 100 pages, contains data on cathode ray oscilloscopes and associated test equipment including pulse generators, sine-wave generators, electronic switches, photographic recording equipment, etc.

**524 STUFFING BOX SEALING**

**Dean Bros. Pumps Inc.**—Circular No. 189 covers the firm's mechanical stuffing box sealing for standard centrifugal pumps. The seals are designed for temperatures from −80 F to 750 F and for pressures from 28 in. vacuum to 100 psi.

**525 SELECTOR VALVE**

**Republic Mfg. Co.**—Catalog No. 356 illustrates and describes a 0-1000 psi pressure balanced selector valve. It is available 2-, 3- or 4-way in sizes from $\frac{1}{8}$ to 1 in.

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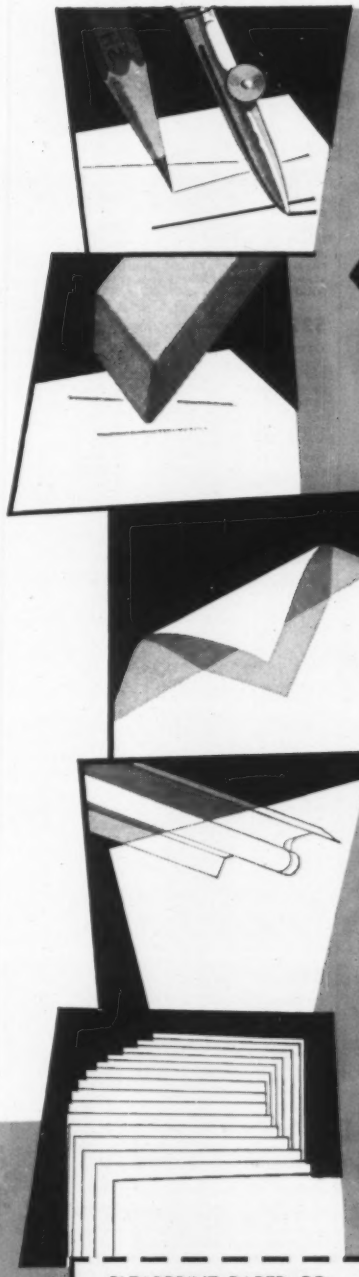

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Panalarm Annunciators are coordinated, multiple-signal systems that instantly alert operators to off-normal process conditions for immediate corrective action. This is particularly valuable when one off-normal condition will cause a "chain reaction" of off-normals with accompanying danger, expense or inefficiency.

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## YOUR *New Catalogs* GUIDE

**526 POWDER METALLURGY PRODUCTS**

**Chrysler Corp., Amplex Div.**—The E-56 Engineering Manual contains details on Oilite power metallurgy products, including self lubricating bearings, finished machine parts and permanent metal filters. The 52-page manual contains a special 12-page insert listing more than 1000 standard sleeve, flange and thrust bearings, cored, solid bar and plate stock.

**527 ADJUSTABLE SPEED DRIVE**

**Dynamatic Div., Eaton Mfg. Co.**—Bulletin FAS5 illustrates and describes the firm's fractional horsepower Ajusto-Spede drive. Fundamentals of operation, capacities, mechanical construction, optional features and controls are covered.

**528 STEAM GENERATORS**

**Springfield Boiler Co.**—A 12-page catalog illustrates and describes indoor and outdoor installations of high pressure, high capacity steam generating units. Data is included on superheaters, economizers, airheaters, steam temperature controls and purifiers.

**529 PLUG VALVES**

**Ohio Injector Co.**—An 8-page bulletin covers iron lubricated plug valves. Diagrams and dimensions are given for each series, along with a description of the principle of operation, specifications of lubricants and such accessories.

**530 CONTROL SYSTEMS**

**Combustion Control Div., Electronics Corp. of America**—Bulletin CA-22 contains information on packaged control systems for commercial and industrial automatic oil, gas and combination burners. Included is application, operation and component data and dimensions.

**531 CHAIN TREATMENT**

**Atlas Chain & Mfg. Co.**—A folder describes electrolizing roller chain for corrosion resistance, higher tensile strength and longer wear.

**532 AUTOMATIC SCALE**

**Exact Weight Scale Co.**—A four-page bulletin illustrates and describes automatic scales and auxiliary equipment for weighing, classifying and sorting products in precise over, under and correct weight groups.

**533 STEEL PIPE**

**Ladish Co.**—An 83-page reference work presents allowable working pressures conforming to Section 8 of the ASA Code for Pressure Piping B31.1.8-1955. Design pressures for various grades of pipe in sizes 6 through 42 in. are numerically tabulated, then plotted in chart form for each of the four basic types of construction covered in this standard.

**534 BOILER, TANK CONTROL**

**Commercial Shearing & Stamping Co.**—Four catalogs are offered. Catalog P-2 covers products for boiler and tank manufacture; H-7 oil hydraulic fluid power controls—pumps, valves, cylinders, motor; P-3, stndard shapes which are available without tool and die charges; G-1, applications and advantages of stampings, forgings and assembled products.

**535 POWER TRANSMISSION BELTS**

**Raybestos-Manhattan, Inc.**—An illustrated brochure covers a new Poly-V belt drive, drawings show its design and operational adantages, and photographs of installations in various idustries are included.

**536 TRACING PAPER**

**B. K. Elliott Co.**—Literature describes "phantom grid" lines designed to facilitate sketching and scale drawing and drop out completely in blueprints and whiteprints. The firm says erasing and corrections leave no trace on the paper, called Ellco-Vel.

**537 SPECIAL GLASSES**

**Corning Glass Wks.**—Properties of such selected commercial glasses as Pyrex, Corning and Vycor are described in bulletin B-83. Data and tables on mechanical properties, thermal stresses, heat transmission, electrical properties, corrosion resistance, and viscosity are included.


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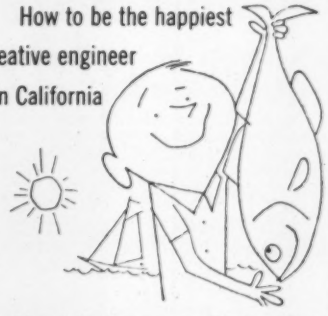

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YOUR

## *New Catalogs* GUIDE

**538 GAS, OIL BURNERS**

**Engineer Co.**—Bulletin OB-53 illustrates different types and sizes of gas and oil burners and includes engineering data and specifications for pumping and heating sets for all types of liquid fuels.

**539 DRAFTING ROOM EQUIPMENT**

**Hamilton Mfg. Co.**—Catalog No. 14 lists steel and wood drawing tables and files for every drafting room need. It includes comprehensive data on the Auto-Shift drafting table, and information about the shallow-drawer unit with tracing lifter.

**540 STEREOMICROSCOPES**

**Bausch & Lomb**—A catalog discusses principles and equipment used in connection with stereomicroscopy. A guide to the selection of stereomicroscopes and accessories is included, along with reproductions of specimens seen through this medium.

**541 PROCESS HEATING EQUIPMENT**

**Union Iron Wks.**—A four-page folder illustrates and describes vaporizers and forced circulation liquid heating and cooling units for use in the process industries. Diagrams and dimension tables of the units are included.

**542 AIR PUMPS**

**Kraissl Co.**—A loose-leaf catalog includes new line of fan cooled air pumps with integrated oil separator and return system, Class 60 series oil pumps approved by Board of Fire Underwriters and Class 72 series separators, inluding all Underwriter listed models for fuel oil service.

**543 FRACTIONAL HP MOTORS**

**General Electric Co.**—Bulletin GEC-1027 gives buying information on fractional horsepower general purpose and definite purpose motors and gear motors, and integral horsepower single-phase and polyphase motors and gear motors.

**544 PRESSURE GAGES**

**U. S. Gauge Div., American Machine & Metals, Inc.**—An 8-page catalog, No. 400, covers the selection of test gages and catalogs them for various applications. A list of check points for ordering pressure gages is included.

**545 SPEED REDUCERS**

**Stephens-Adamson Mfg. Co.**—Catalog 643 covers single and double reduction type speed reducers. Specifications and dimensions are tabled, and installation information is given. A section of the 12-page booklet deals with the firm's materials handling equipment.

**546 FLEXIBLE CHAIN COUPLINGS**

**Morse Chain Co.**—A 16-page catalog gives specifications, dimensions, ratings and applications on series DSC and series SA silent chain couplings and series DRC roller chain couplings. Tabulated information on stamped steel covers, plastic covers and split aluminum covers is included.

**547 AUTOMATIC CONTROL**

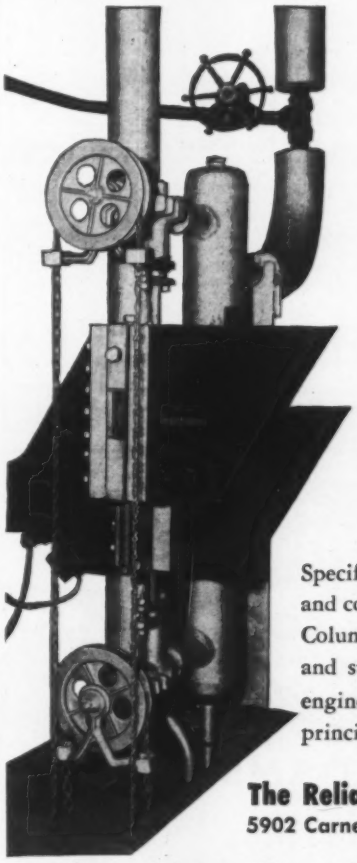
**Assembly Products, Inc.**—Catalog 4B illustrates and describes principles of automatic control with contact meter-relays. Included are specifications and prices on meter-relays, VHS relays, load relays and plug-in units, automatic control packages and components, panel meters, indicating pyrometers. A 6-page section of diagrams and text deals with circuitry and includes response time tables and a discussion of non-locking contacts.

**548 INDUSTRIAL SPRAY NOZZLES**

**Spraying Systems Co.**—Catalog No. 24 a new spray nozzle catalog, contains capacity and spray characteristic data. Said to be the most complete industrial spray nozzle catalog ever produced, it illustrates nozzles for producing hollow cone, full cone, flat, solid stream, and pneumatically atomized sprays. Nozzles made of special materials are also illustrated with capacity tabulations, such as nozzles with wearing points reinforced with tungsten carbide.


# Reliance Water Columns

## Gages and Safety Specialties assure you the utmost in *Dependability*



Since 1884, Reliance has maintained leadership in Boiler Safety Device development and manufacture. Water Columns with automatic Alarms, operated by the original *instantaneous* alarm mechanism, have helped to fortify power plants against the consequences of boiler water failure for billions of operating hours. Whistle alarms are available on columns for pressures to 900 psi; electric alarms, actuated by Reliance Electrode Levalarms, to 2500 psi.

For higher pressures — to 2500 psi — Reliance standard and custom-built equipment embodies principles of design and construction perfected in 70 years of *specializing* in this field—"super-rugged" Water Columns built with a generous margin of safety and tested at twice rated capacity.

Specified by many boiler manufacturers and consulting engineers, Reliance Water Columns exceed requirements of national and state code authorities . . . Reliance engineer representatives are located in all principal cities. Write for Bulletin 516.

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**Reliance Water Column Accessories, and Specialties**

Water Gage Valves  Gage (try) Cocks
Gage Inserts: Prismatic, Mica-protected Flat Glass, "Micasight"
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Complete Line of Water Gage Illuminating Equipment
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Levalarms — Float-type Liquid Level Alarm Devices
Levalarms — Electrode-type Liquid Level Alarms, Fuel Cut-out and Pump Control

*The name that introduced safety water columns....in 1884*

**Reliance®**

**BOILER SAFETY DEVICES**

YOUR

# New Catalogs GUIDE

## LATEST INDUSTRIAL LITERATURE

### 549 PLANT SKYLIGHTING

**Resolite Corp.**—A 4-page folder illustrates use of Fiberglas panels for industrial plant skylighting. It includes fire retardant Fire-Snuf, now Factory Mutual approved and labeled by Underwriters' Laboratories. Data on light transmission, weights, loading characteristics and a table of sheet sizes and corrugations are included.

### 550 PLOTTER, RECORDER

**Librascope, Inc.**—An eight-page bulletin illustrates and describes XY plotters and recorders for application in research facilities, computer systems, controls and data handling systems.

### 551 SNUBBER

**Burgess-Manning Co.**—Literature describes a recently developed water separator snubber designed to control the exhaust temperature to safe limits when mounted on exhaust manifolds of fuel barges during unloading operations.

### 552 REMOTE VALVE CONTROL

**Stow Mfg. Co.**—A 16-page design manual covers the use of flexible shafting for remote valve control. A chart is given for the selection of the correct size shaft for any valve. Different types of end connections are shown.

### 553 WELDING PIPE FITTING

**Bonney Forge & Tool Wks.**—A data sheet illustrates and describes a unique branch welding pipe fitting for constructing angular branch connections with a full penetration weld. The units, called Elbolets, are used for making 45-deg. connections for directional flow and instrument connections, and for connections into elbows for instruments, drips, hanger and support connections.

### 554 ALLOY STEELS

**Bethelehem Steel Co.**—A 32-page booklet contains 16 brief articles on elements, grain size, heat-treatment, quenching media, depth-hardness, and other pertinent topics; also several pages of tables on standard alloy steels, tentatve standard steels, boron steels, H-steels.

### 555 BELT IDLERS

**Joy Mfg. Co.**—Bulletin LD-105 gives specifications on belt idlers. Included is application data on bolt-on and portable types of the firm's Limberoller, a flexible, single-roll belt conveyor idler suspended from a bearing at each end to form a natural troughing catenary.

### 556 PIPE WRAP

**Rhopac, Inc.**—Literature describes a new pipe-wrap which combines an under-wrap of quality glass fiber insulating material and an outer wrap of vapor sealing tape. The new wrap is said to prevent concensation and sweating of cold water pipes and provide a highly efficient insulation for hot water pipes.

### 557 STEEL BOILERS

**National-U. S. Radiator Corp., Pacific Steel Boiler Div.**—A four-page catalog, AP-282, features four sizes of plate flue steel boilers for residential installations. Instead of conventional boiler tubes, these units are equipped with plate flues made of 1/4-in. flange-quality boiler plate designed to assure longer flue life.

### 558 CUSTOM GEARS

**Cincinnati Gear Co.**—Illustrated folder describes and shows examples of types of gears produced to individual specifications only for all types of machinery and products. Gear types listed include spur, helical, rack, worm, herringbone, bevel, spiral bevel, internal, sprocket, zerol and coniflex.

### 559 PNEUMATIC CONTROLS

**Westinghouse Air Brake Co.**—A 12-page catalog illustrates and describes the various kinds of valves and devices used in pneumatic control systems. This bulletin includes diagrams showing how to use some of the valves.

Your NEW CATALOGS Guide offers readers of MECHANICAL ENGINEERING an opportunity to secure advertisers' latest industrial literature available. In this issue there are 559 items to make selections from. For convenience an index may be found on pages 43 and 44. Select desired catalogs by number, requests limited to 25 catalogs. Fill in coupon on page 44 and mail promptly. *(Must be mailed on or before date given on coupon.)*

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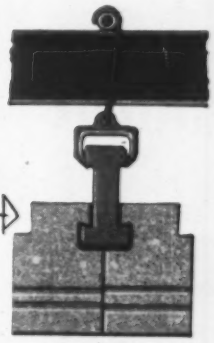
# This tile is called a dog bone!

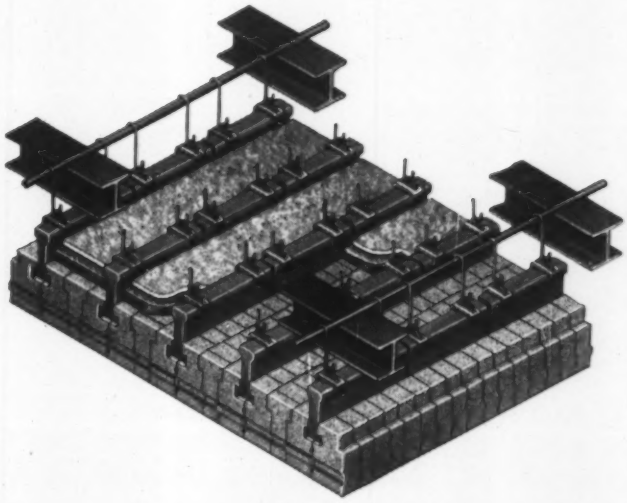
It's a husky supporting tile—used instead of an expensive alloy casting in a double suspended arch designed by B-L for high temperature aluminum, steel and glass furnaces. It can stand extremely high temperatures—can be used with or without insulation.

## The dog bone supports two beam tile.



Bottom lugs are sloped so that the weight of the beam tile will draw the two together—like this:

## Filler tile space out the arch so that the completed job looks this way:



Naturally the completed arch will possess all of the inherent characteristics of Bigelow-Liptak suspended construction. Burned out or damaged tile can be removed without disturbing large areas. Expansion is confined to individual tile—will not accumulate over the entire width of the arch. It all adds up to more production—less down time through keeping heat from raising the roof.

**We'd like to tell you more about it. Just write.**

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AND BIGELOW-LIPTAK EXPORT CORPORATION
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# NEW

## weather-resistant, corrosion-resistant GRINNELL VARIABLE SPRING HANGERS...

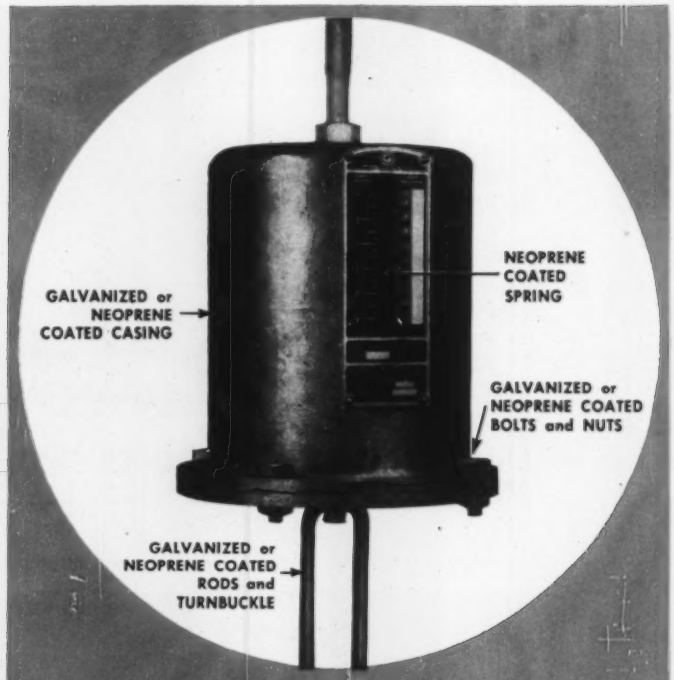
### Another Grinnell First!

Grinnell pre-engineered spring hangers are now offered in two new lines to meet the need for spring hangers in installations subject to highly corrosive industrial conditions and to severe weather exposure.

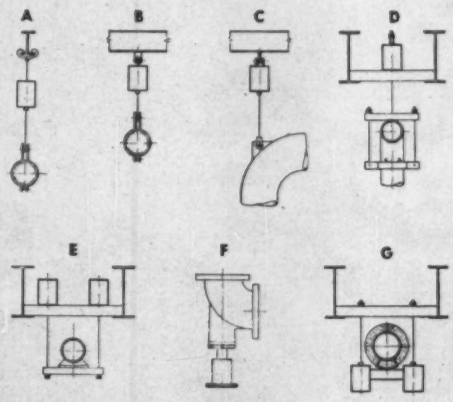
These hangers are the result of extensive experimentation with various coatings for Grinnell's standard pre-engineered spring hangers. In addition to providing flexibility in pipe suspension, they provide versatility of application through their corrosion-resistant characteristics. They are . . .

1. Neoprene coated—for highly corrosive conditions such as those found in chemical plants and refineries. *All* parts of the hanger are neoprene coated to protect the base metal from a wide range of corrosives. The flex life of the spring is unaffected by the neoprene . . . the coating resists cracking or flaking over a wide temperature range.

2. Galvanized—for outdoor installations where weather conditions are severe. All parts of the hanger are galvanized except the spring, which is neoprene coated to avoid alteration of temper, hydrogen embrittlement and decreased flex-life of the spring—usual hazards to springs from the galvanizing process.


GALVANIZED or NEOPRENE COATED CASING
NEOPRENE COATED SPRING
GALVANIZED or NEOPRENE COATED BOLTS and NUTS
GALVANIZED or NEOPRENE COATED RODS and TURNBUCKLE

**AVAILABLE IN 7 TYPES FOR THESE TYPICAL APPLICATIONS**




(A) Rod threaded to top cap (B) Furnished with single lug (C) Two lug style (D) Top adjusting (E) Adjustable top and bottom (F) For floor support (G) Trapeze assembly.

**Along with the obvious advantages of such corrosion and weather-resistant characteristics, consider these features...**

- Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes.
- Precompression* assures operation of spring within its proper working range, as well as saving valuable erection time. Reduced over-all height saves space.
- 18 sizes available from stock for load ranges from 53 lbs. to 12,000 lbs.
- Available in 3 spring lengths for travel ranges of 1¼, 2½, and 5 inches.
- Installation is simplified by integral load scale and travel indicators.

**Precompression is a patented feature.*

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FITTINGS 1/8" THROUGH 36"

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| IPS WELDING FITTINGS | | ½" through 36" From Sch. 5S to wall thicknesses through 4" |
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| 150 LB. SCREWED FITTINGS | | ⅛" through 4" |
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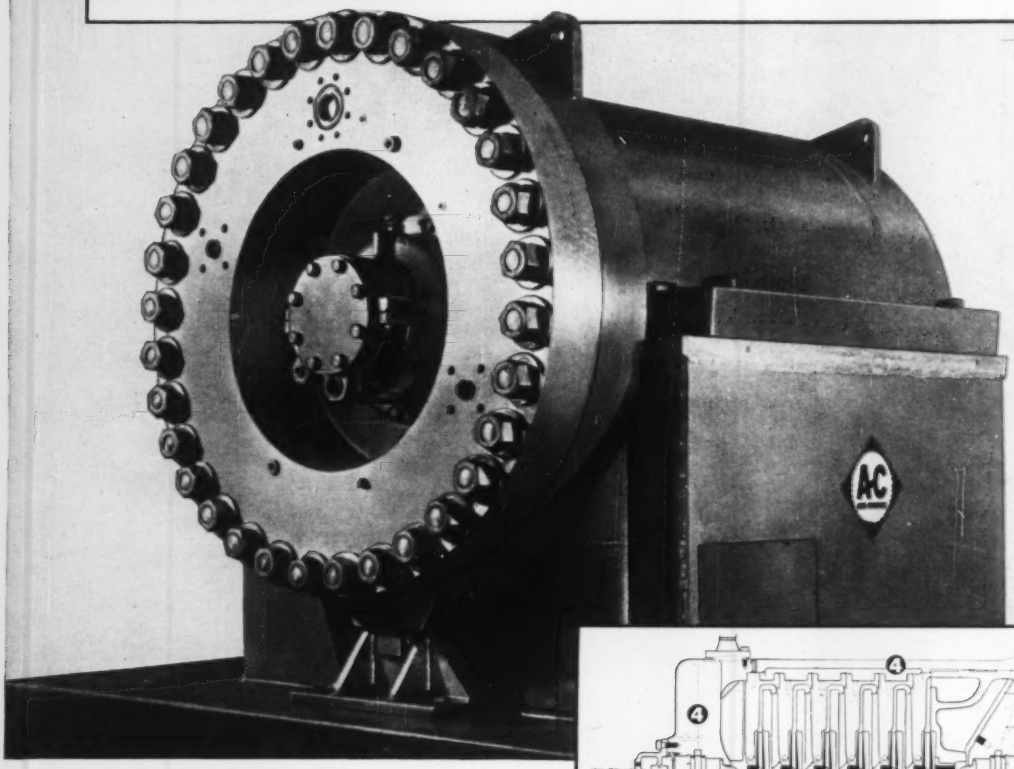
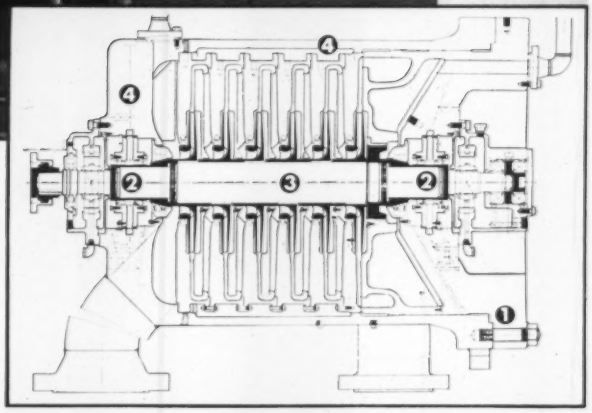
*Also furnished in any forgeable material specification including... Titanium, Aluminum, Copper, Nickel, and Chromium Base Alloys.

**ALLIS-CHALMERS**
**High Pressure**
**Barrel-Type**
**COMPRESSORS**

# for Non-Stop Service






'Round-the-Calendar Operation is built into the complete line of Allis-Chalmers high pressure barrel-type units for reforming processes. Here are four reasons for their dependability:

**1.** Simple to Maintain — Only one head bolted. Spiral-wound metallic gasket provides positive seal of casing joint.

**2.** Shaft Sealing — Double bushing seals have separate high pressure oil system. Inward seal leakage minimized.

**3.** Rugged Rotor — Impellers shrunk and keyed to shaft. Riveted impellers have rivets milled integrally from blade edge.

**4.** Extra Strong — Vertically split forged steel casings give maximum safety at high pressures.

Find out more by contacting your nearby A-C office, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

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A-C ALLIS-CHALMERS

A-5107

# Aluminum Ideas — BUY the dozen

**1**

### EXTRUDED ALUMINUM TUBE

Wolverine extruded aluminum tube is available in a wide range of sizes in popular alloys. Like all Wolverine products it is rigidly quality controlled.

**2**

### DRAWN ALUMINUM TUBE

At Wolverine, batteries of draw benches—manned by operators skilled in Tubemanship—produce drawn aluminum tube in popular alloys in a wide range of sizes.

**3**

### ALUMINUM TUBE IN COILS

Wolverine aluminum tube is also available in medium and extra long coils—ideal for reducing handling and storage space.

**4**

### WOLVERINE TRUFIN® TYPE S/T

Available in lightweight aluminum, integrally finned Trufin Type S/T is designed especially to boost performance of shell and tube heat exchangers and condensers.

**5**

### WOLVERINE TRUFIN TYPE I/L

An all aluminum tube, Type I/L has helical fins on its exterior surface and longitudinal fins on the inside. It is designed especially for air-cooled heat transfer operations.

**6**

### WOLVERINE TRUFIN TYPES H/A AND H/R

These high finned condenser tubes are also designed for air-cooled heat transfer operations. They are available with various fin spacings in a wide range of sizes.

**7**

### WOLVERINE DUPLEX CONDENSER TUBE

Designed to offset simultaneous corrosive attack on two sides; this type of condenser tube can have an inner—or outer tube of lightweight aluminum mechanically bonded to another tube of any desired alloy.

**8**

### EXTRUDED SHAPES

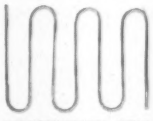
Wolverine extrudes aluminum shapes to customer specifications. Rigidly quality controlled, these extrusions help manufacturers reduce machining and assembly operations, save on material requirements.

**9**

### EVAPORATOR SUB-ASSEMBLY

Prefabricated evaporator sub-assemblies are real time, equipment and labor savers. They are composed of a bunch-type aluminum coil, a one-piece aluminum accumulator and two aluminum-to-copper connectors.

**10**



### SERPENTINE COIL

Wolverine aluminum serpentine coils permit manufacturers to place a maximum length of tube in a small area. Wolverine is also equipped to coil, flare, expand, etc.

**11**

### ALUMINUM-TO-COPPER CONNECTORS

Available in ⅜" and 5/16" tube diameters, handy connectors permit manufacturers to use both copper and aluminum tube in the same refrigeration cycle.

**12**

### SPUN END PARTS

With its Aluminum Spun End Process†† Wolverine produces a wide variety of tubular-shaped parts with fully or partially closed end treatments in one, economical operation.

††PROCESS PATENT APPLIED FOR

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*Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.*

# Boeing "M.E.'s" help design America's first jet transport

Pictured above is the full-scale cabin mock-up of the Boeing 707, America's *first* jet transport. In developing this interior, Boeing engineers helped design features and innovations as advanced as the 600-mile-an-hour performance of the aircraft itself.

Pioneering revolutionary new types of aircraft is a source of excitement — and satisfaction — for Boeing mechanical engineers. For the 707 cabin, "M.E.'s" helped develop an entirely new principle of seat installation, worked on vibration control and helped develop an advanced system of air conditioning. Orders for the 707, along with a tremendous backlog of military contracts, assure Boeing expansion for years ahead.

Growth is a Boeing habit. During the past 10 years, for instance, the number of Boeing engineers has increased 400%. Expansion at this rate spells job stability — and plenty of opportunity to move ahead. Boeing promotes from within, and holds merit reviews every six months to give each engineer a *personal* opportunity for recognition, advancement and increased income.

Boeing engineers don't get lost in the crowd. They work in small integrated teams — on such projects, in addition to the 707, as the B-52 and B-47 jet bombers, the BOMARC IM-99 guided missile, the 502 gas turbine, and other developments still under security wraps.

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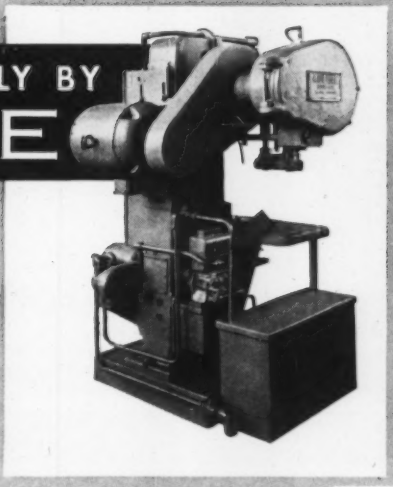
# OILGEAR "JK" FEED PUMPS

## USED EXTENSIVELY BY MOLINE

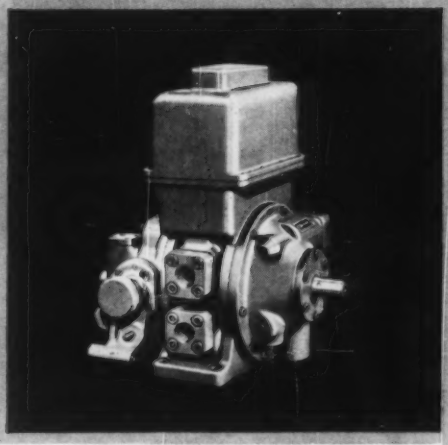
The Moline Tool Company, long established and respected in industry, has used Oilgear Fluid Power Feeds since 1925. Of Oilgear "JK" Fluid Power Feed Pumps used in its machines, Moline says these pumps *combine* the advantages found only in part in various mechanical feeds. Also, the "JK" Feed Pump provides infinitely, steplessly variable speeds; you can easily find the speed best suited to the work or condition of tools. Traverse speed can be as much as 265 times the feed rate. Coarse and fine feed rates are variable over a 20 : 1 range. Cycle time is cut drastically, production increased, costs reduced. Feed rates are maintained accurately despite varying work pressures by a built-in automatic pressure compensator.

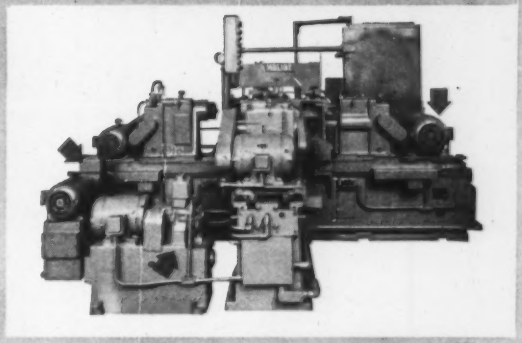
"JK" Feed Pumps are simple, compact, electro-hydraulically controlled units, easily installed nearby or remotely. Systems need only a pump with reservoir, a double-acting cylinder, standard control and two easily connected pipes. Eliminating expensive engineering, these units can simplify design, reduce manufacturing cost, improve performance and increase saleability of machines. Manual, semi-automatic or full automatic operation. Available now in 4 sizes. Write for free literature.

THE OILGEAR COMPANY
1570 West Pierce Street
Milwaukee 4, Wis.



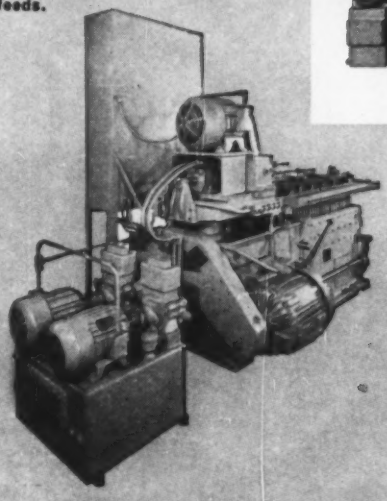
Above, Moline Drilling Machine employing "JK" Feed Pump.



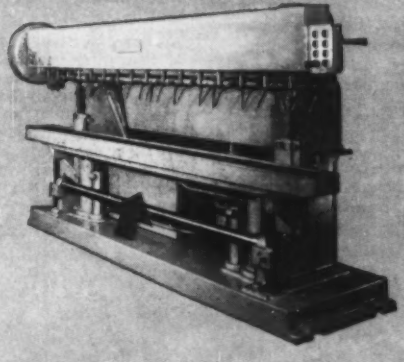


Moline 4-way horizontal boring machine uses 4 Oilgear "JK" Feed Pumps.

Below, Moline special 56-spindle back-spotfacing machine using 2 "JK" units for vertical and horizontal feeds.



Below, Moline ten-foot, straight-line drilling machine using "JK" Feed Pump.



**"JK" PUMPS EASILY APPLICABLE TO YOUR MACHINES FOR BETTER PERFORMANCE**

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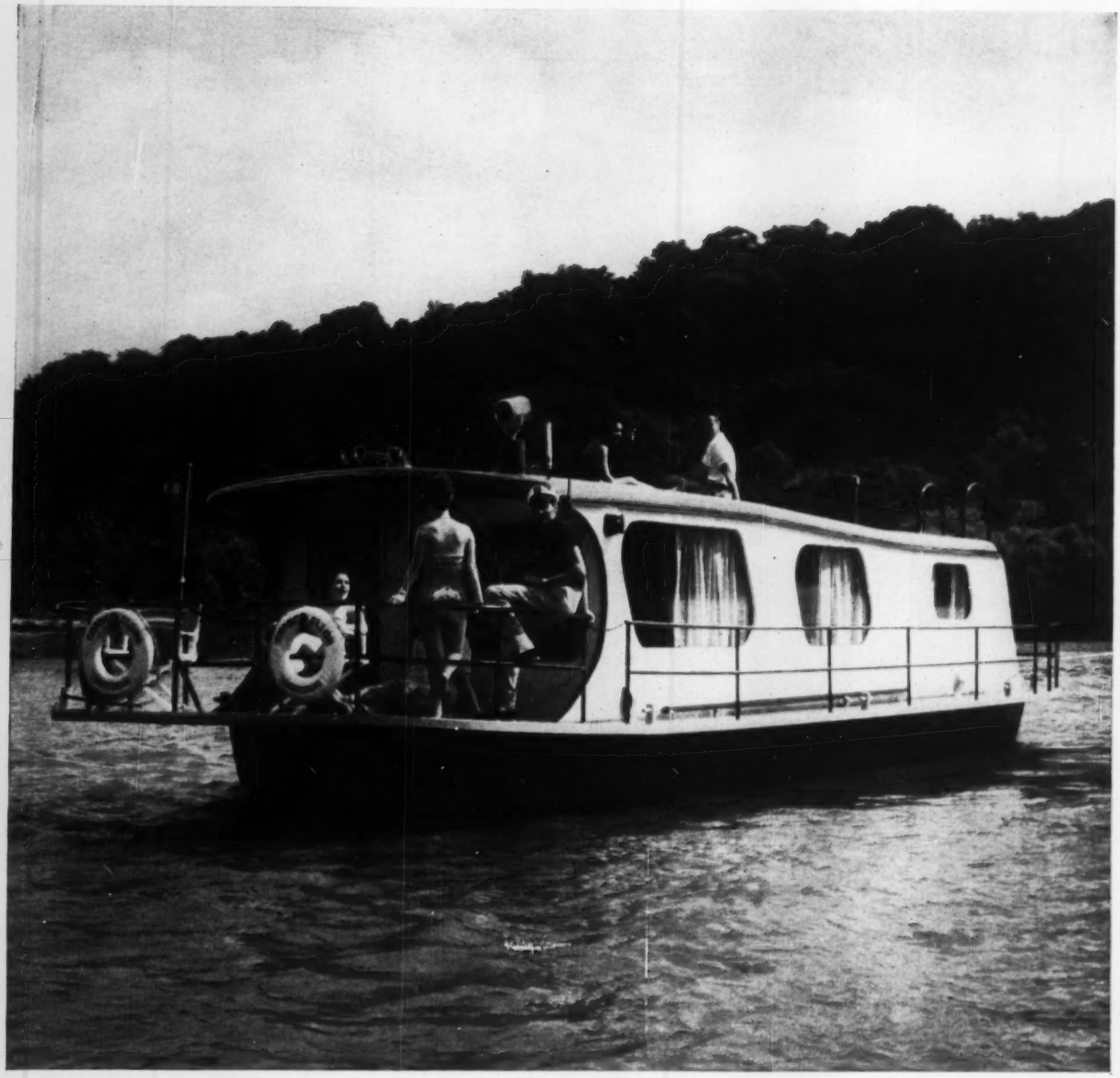
# You can build it better



**BUILT TO LAST.** Light in weight, strong and tough, highly resistant to corrosion and abrasion, the 40-ft. hull of this attractive houseboat, built of 12-ga. USS COR-TEN Steel, has what it takes to give long years of low-maintenance, trouble-free service. Customarily beached by being run right up on the shore, this boat needs COR-TEN Steel's superior strength and high resistance to wear and impact to withstand such rough usage. Says the owner, "Despite the fact that on five different occasions the boat has been dropped from the dry-dock from heights ranging from 6 to 12 feet—treatment that would have completely wrecked a boat of usual construction —the 5½-year-old hull is still in excellent condition and appears good for many, many more years." (This all-steel boat was constructed by Kelly Shop, Inc., Jeffersonville, Ind.)

• • •

**USS COR-TEN** Steel has been approved by the American Bureau of Shipping for use in hull construction, either riveted or welded, with a general reduction from mild steel weights or sections of about 10 per cent. Lloyds Register of Shipping has stated that COR-TEN Steel is acceptable under its rules as a special quality steel for ship building. Its use in oil tankers, ore boats, dredges, barges and pleasure craft, both in fresh and salt water service during the past 23 years, has definitely proved USS COR-TEN Steel's exceptional fitness for marine construction.

# with USS High Strength Steels

In USS High Strength Steels, design engineers have at their command three service-tested steels that will permit them to materially increase the efficiency and economy of machinery, equipment and structures at little or no increase in first cost . . . and frequently at less cost.

All three of these famous "*steels that do more*"—USS Cor-Ten, USS Man-Ten and USS Tri-Ten "E"—have a 50% higher yield point than plain carbon steel. All have better atmospheric corrosion resistance and offer greater resistance to wear, fatigue and impact. Each, however, has specific superior properties that should be considered in determining its selection.

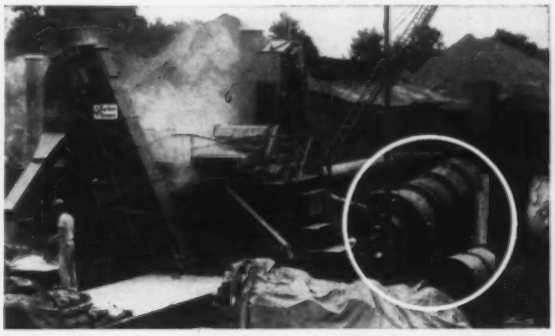
USS Cor-Ten Steel, for example, is distinguished by its superior resistance to atmospheric corrosion—4 to 6 times that of carbon steel. USS Man-Ten Steel is intended for weight reduction by means of greater strength in moderate forming applications, with enhanced resistance to abrasion and atmospheric corrosion. USS Tri-Ten "E" Steel's outstanding characteristics are excellent weldability and resistance to shock.

Used singly or in combination, these steels can advantageously replace carbon steel to increase the strength and durability of vital parts *without* increasing their weight. Or when the use of thinner sections is feasible, they can (1) reduce equipment weight without reducing its strength, or (2) increase the size and capacity of equipment without increasing total weight or the power required to move it.

• • •

You will find our 174-page "*Design Manual for High Strength Steels*" extremely useful in applying the benefits of these steels to your product. Send for free copy—simply write on your company letterhead to United States Steel Corporation, Room 2801, 525 William Penn Place, Pittsburgh 30, Pa.

**"PREGNANT PLATYPUS."** That's what the designers call this new combination trailer made to carry two completely unrelated types of products. Going in one direction it hauls 800 gals. of glue in the "dromedary" tank and 4,000 gals. in the belly tank below the trailer. On the return trip it carries 42,000 lbs. of plywood in the trailer van. To reduce empty weight and obtain greater strength—and at the same time to provide resistance to the mildly corrosive glue carried—USS Cor-Ten Steel was used in both tanks and in the trailer frame, body framing and cross frame members as well. As a result, the unit weighs 1,800 lbs. (11½%) *less* than if mild steel had been used, and will carry maximum payload, require less maintenance and last longer. Built by Peerless Trailer and Truck Service, Portland, Ore., for M and M Wood Working Company.



**TO BEAT HEAT AND ABRASION.** This asphalt mixing plant produces tar or asphalt road-paving mixes at a rate of more than 60 tons per hour. In the dryer, which removes the moisture from the sand and stone in the aggregate, temperatures run as high as 800° F. Abrasive action is severe.

To meet these conditions the Barber-Greene Co. of Aurora, Ill., builds the entire dryer drum (circle) of USS Man-Ten Steel. In this way they obtain one and a half times greater yield point than with carbon steel, greater abrasion resistance, and greater resistance to heat, impact and vibration. These qualities pay off by keeping the equipment more continuously on the job.

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COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
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**USS HIGH STRENGTH STEELS**

USS MAN-TEN • USS COR-TEN • USS TRI-TEN

UNITED STATES STEEL

1933 USS HIGH STRENGTH STEELS 1956 — 23 YEARS OF PERFORMANCE

# *Important Dimensional Standards and Construction Codes Published by the ASME*

## BOLTS, NUTS, RIVETS, AND SCREWS

In these American Standards will be found the proportions and dimensions, the tolerances, recommendations for material, and other pertinent data.

Large Rivets (½ Inch Nominal Diameter and Larger), B18.4—1950. $1.50

Small Solid Rivets, B18.1—1955. $1.50

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High - Strength, High - Temperature Internal Wrenching Bolts, B18.8—1950. $1.00

Slotted and Recessed Head Wood Screws, B18.6.1—1956. $1.00

Hexagon and Slotted Head Cap Screws, Square Head Set Screws, Slotted Headless Set Screws, B18.6.2—1956. $1.50

Socket Head Cap Screws and Socket Set Screws, B18.3—1954. $1.50

Square and Hexagon Bolts and Nuts and Lag Bolts, B18.2—1955. $2.00

Track Bolts and Nuts, B18.10—1952. $1.50

## PIPE, PIPE FITTINGS, AND THREADS

These American Standards cover dimensions and tolerances, pressure ratings, size, marking, material, and threading.

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Brass or Bronze Screwed Fittings 125 Lb, B16.15—1947 (Reaffirmed 1952). $1.50

Brass or Bronze Screwed Fittings 250 Lb, B16.17—1949 (Reaffirmed 1953). $1.00

Cast-Brass Solder-Joint Fittings, B16.18—1950. $1.50

Cast-Brass Solder Joint Drainage Fittings, B16.23—1955. $1.50

C I Pipe Flanges and Flanged Fittings for: 25 Lb Psi, B16b2—1931 (Reaffirmed 1952). $1.00

CLASS 125, B16.1—1948. $1.50

CLASS 250, B16b—1944 (Reaffirmed 1953). $1.50

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Pipe Threads, B2.1—1945. $2.50

Scheme for the Identification of Piping Systems, A13.1—1956. $1.00

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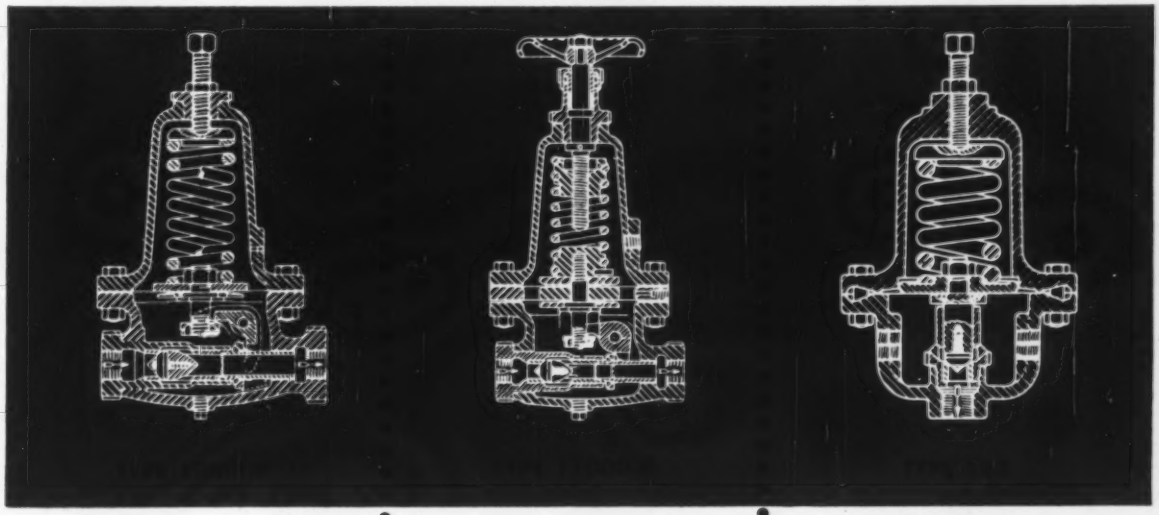


### PRESSURE REDUCING VALVE

A streamlined high capacity valve for close pressure regulation—accurate even under toughest working conditions. Closes against the flow, eliminating conditions that cause chatter. Two types available: for high pressures and for low pressures. Recommended for steam, water, air, oil and most gases and chemicals. Screwed ends, sizes: ¼″ to 2″.

### DIFFERENTIAL CONTROL VALVE

Maintains constant differential pressure between atomizing steam and fuel oil. Non-rising type adjusting screw adjusts spring either under tension or compression for maintaining steam above or below fuel oil pressure, depending on type of burner employed. Iron, bronze or steel body; bronze or stainless steel trim. Screwed ends, sizes ¼″ to 2″ with expanded outlets when desired.

### RELIEF VALVE

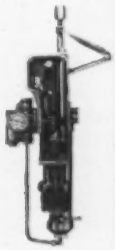
Maintains a desired inlet pressure by relieving into relief line provided or protects equipment against high pressure line surges. For water, oils, air, gases, slurries and many other fluids. Bottom connection is outlet or discharge connection. Two side inlet connections permit installation in the line or as an angle valve with one side inlet plugged. For relief pressures to 325 lbs. and temperatures to 500° F. Screwed ends, sizes: ¼″ to 2″; flanged ends, size ½″.

Cash Standard
Stacon Series V Self Operating Temperature Regulators

Type 57
Recording Controllers

Type 30
Diaphragm Control Valve With Type 51 Indicating Controller Mounted

Type 44
Pilot Operated Pressure Regulator



Type 100
Positioning Controller

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PRESSURE, HYDRAULIC, TEMPERATURE, PROCESS AND COMBUSTION CONTROLS

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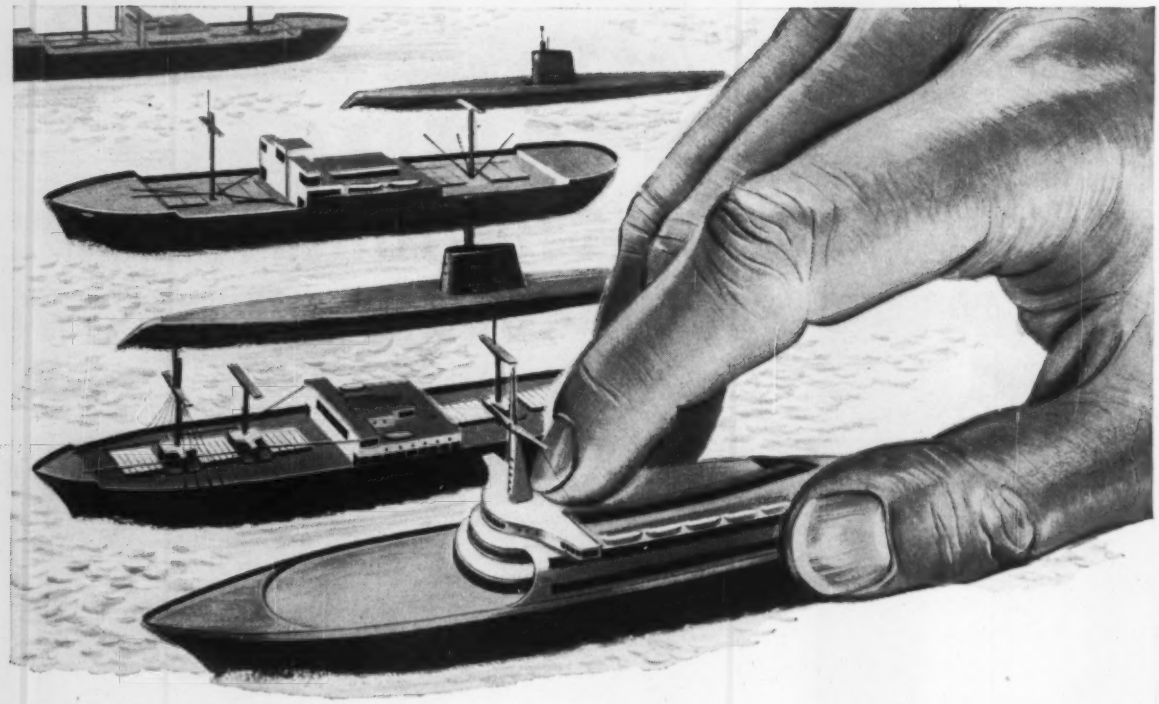

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Nuclear power offers tremendous advantage for naval vessels. From the fuel standpoint, cruising ranges are virtually unlimited—even at new high speeds. No refueling facilities will be required to replenish nuclear propulsion fuel. Therefore, the physical design of the fleet can be streamlined for greater efficiency and safety.

At the country's largest design-engineering center for nuclear power reactors, Bettis Plant in Pittsburgh, operated for the Atomic Energy Commission by Westinghouse, the application of nuclear power has progressed rapidly. However, the nuclear power plants already in operation today represent only the beginning of a new technological era. *Major advances in many areas are necessary.*

The complexities of handling nuclear materials and controlling the reactor have opened up a whole new field in mechanism design. Atomic power plant equipment requires engineers who are capable of developing the unique valves and pumps that are required in the primary system of a pressurized water reactor. In addition, boilers, heat exchangers, steam generators and other plant equipment require special design and development work.

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Atomic experience is not necessary.

What's more, Bettis Plant is in Pittsburgh's South Hills. Here you can enjoy good living in pleasant suburbs near the plant, and still be convenient to one of the nation's most progressive metropolitan areas.

Educational opportunities are exceptional. Westinghouse helps you continue your studies at any one of three Pittsburgh universities.

**Write for descriptive brochure on opportunities in your field. Be sure to specify your interests. Address Mr. A. M. Johnston, Westinghouse Bettis Plant, Dept. A91, P. O. Box 1468, Pittsburgh 30, Pa.**

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**Westinghouse**

Here is an entirely new series of clutches combining, in a single compact unit, all of the PROVED advantages of MAXITORQ Floating Disc Clutch design with an exceptionally simple, powerful, and dependable electro-magnetic actuating mechanism.

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- **WET OR DRY** operation.
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Members of the ASME are invited to name any number of engineers as candidates for membership. Engineering acquaintances should be qualified by both fundamental training and experience for one of the technical grades. Those who do not have an engineering degree may show the equivalent thereof through actual practice. Executives of attainment in science or industry may associate with the Society as Affiliates.

THE American Society of Mechanical Engineers promotes Mechanical Engineering and the allied arts and sciences, encourages original research, fosters engineering education, advances the standards of engineering, promotes the intercourse of engineers among themselves and with allied technologists; separately and in cooperation with other engineering and technical societies, and works to broaden the usefulness of the engineering profession.

As a post graduate school of engineering, the Society brings engineers into contact with each other, with leaders of thought and with new developments; it fosters the interchange of ideas, develops professional fellowships, and encourages a high standard of professional conduct—all with the purpose of advancing civilization and increasing the well-being of mankind.

C. E. Davies, Secretary
The American Society of Mechanical Engineers
29 West 39th Street, New York 18, N. Y.

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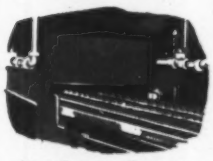

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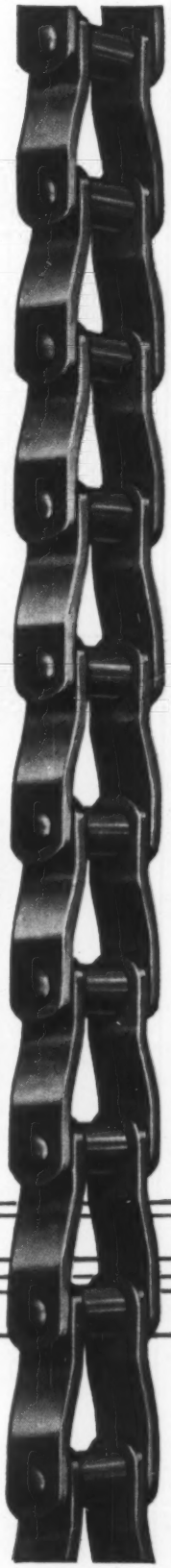

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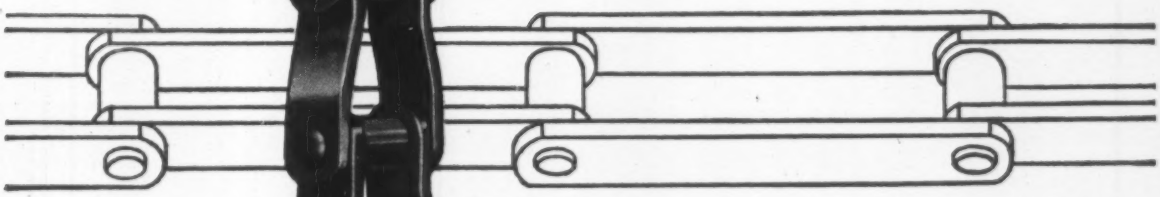
Whether that cost is first or operating, it will pay dividends to investigate the saving possibilities of Rex Chabelco Steel Chain. It has the *extra* strength, *extra* stamina and *extra* quality needed for longer trouble-free operation.

For drive or conveyor service, where loads are heavy, speeds slow to moderate... where operating conditions involve temperature extremes, dust, dirt or heavy shock loads—*these steel chains will save you important money.* And, they run on cast sprockets...another important cost-cutting advantage.

Why not have your Chain Belt Field Sales Engineer check your chain requirements with you. He may be able to save you important money—he has for other Design Engineers. Meanwhile, send for Bulletin 56-57. Chain Belt Company, 4765 W. Greenfield Ave., Milwaukee 1, Wisconsin.



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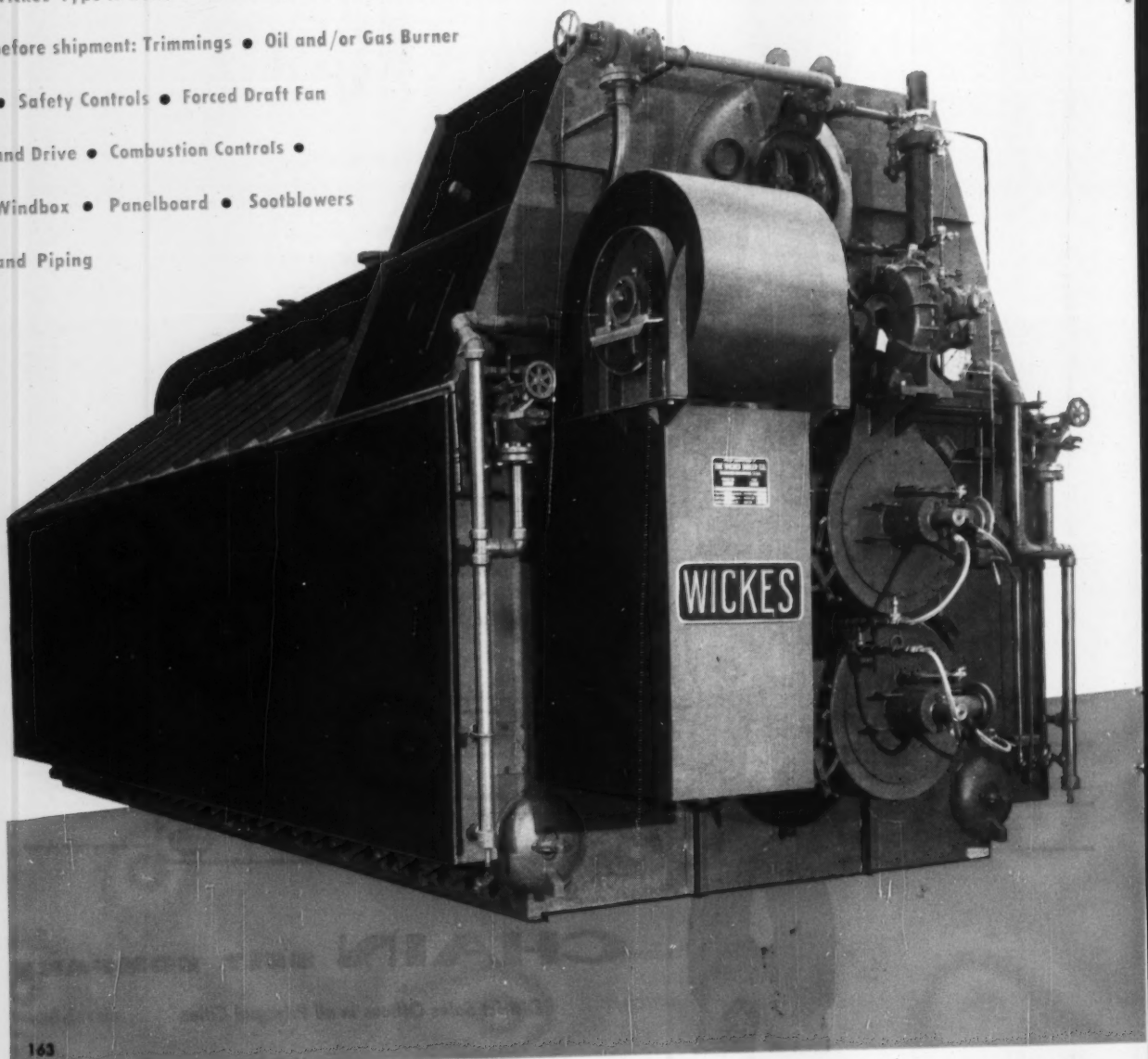


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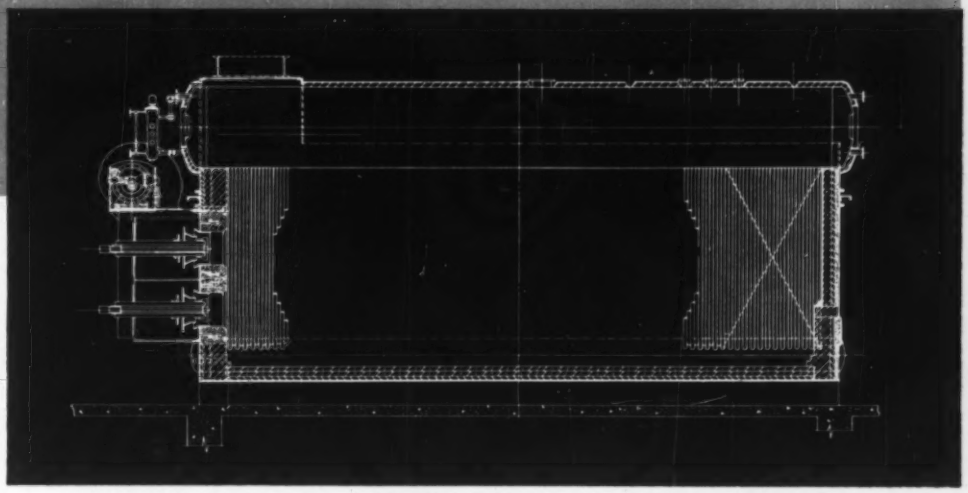
# HOUR WITH A SHOP-ASSEMBLED STEAM GENERATOR



With capacities for sustained steam production up to 60,000 lbs. per hour the Wickes Type-A Boilers give you "packaged power" ready for immediate installation. They are custom engineered to your requirements and shop-assembled to reduce interruption of operations in your plant to a minimum. Wickes Type-A packaged boilers conserve headroom and floor space and are very simple in design . . . the large furnace is located between two banks of boiler tubes so that each furnace wall is a separate steam generator as well as an integral part of the boiler unit. The steam generator is enclosed in a high quality refractory and insulation setting and protected by a pressure-tight steel casing . . . thus, the pressurized furnace can be operated without a high stack or induced draft fan when burning oil or gas. This casing is also completely weatherproof for outdoor installation.

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WICKES type A

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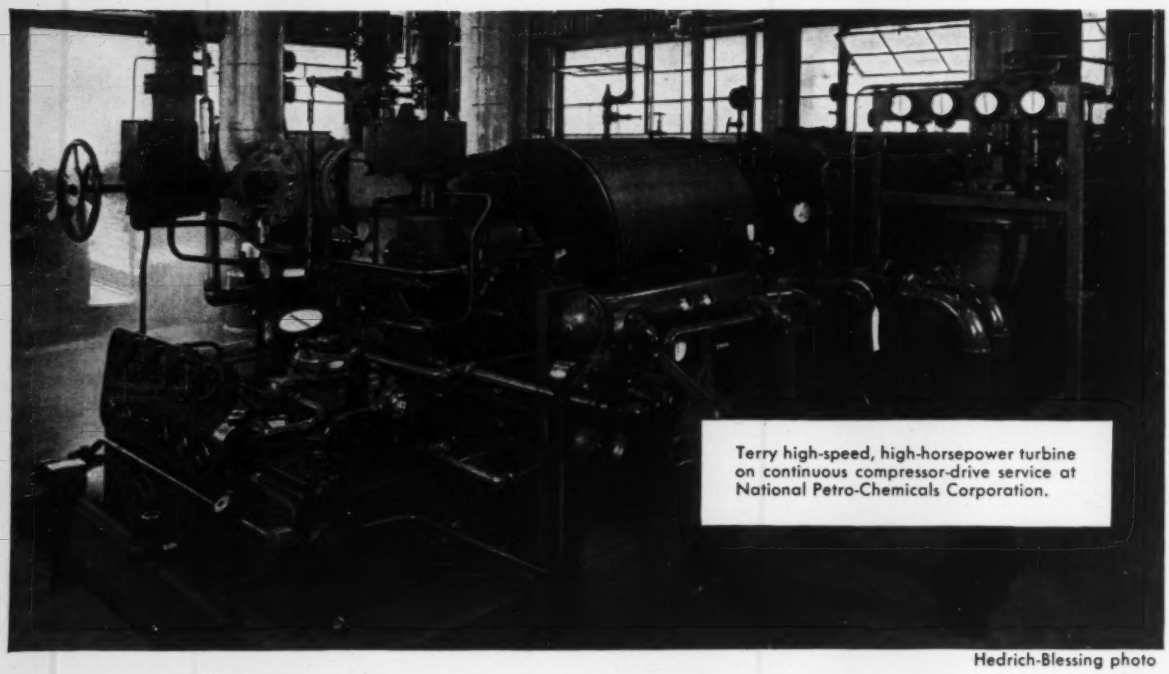
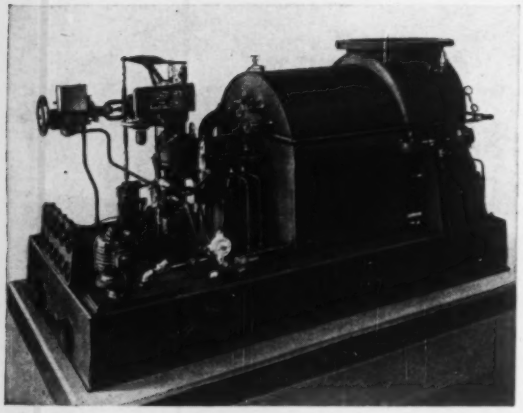


Terry high-speed, high-horsepower turbine on continuous compressor-drive service at National Petro-Chemicals Corporation.

Hedrich-Blessing photo

*At National Petro-Chemicals Corporation . . .*

# Terry high-speed compressor-drive turbines provide continuous 'round-the-clock service



One of the two 5400 hp., 7486 rpm turbines built for the Tuscola plant of National Petro-Chemicals Corporation.

In the fall of 1953, five Terry multistage turbines were placed on day-and-night duty at the Tuscola, Illinois, Plant of National Petro-Chemicals Corporation. They drive high-speed compressors used to compress hydrocarbon gases in the production of ethylene.

The *excellent performance of these initial units later resulted in the installation of two more Terry machines.* These were placed in service some two years later.

In all, the seven turbines total more than 30,000 hp. They range in capacity from 3300 to 5400 hp., and in speed from 7500 to 9700 rpm.

The National Petro-Chemicals installation, and the thousands of other units serving in refineries and chemical plants throughout the world, are testimony to the low maintenance and consistent reliability of Terry turbines. Put Terry to work for you. Write for further information.

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- Shelf and storage drawer arrangements to suit individual needs.
- Large sliding reference shelf for extra convenience.
- Designed for space-saving row installation.
- Accommodates parallel straight edge, drafting machine, lamp.
- Exclusive Flexi-Belt and Roto-Positioner delivers the work to the man.

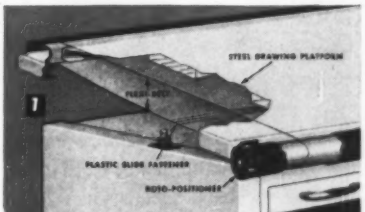
# Save valuable floor space with the new GF Draft-a-Matic®

When you install Draft-a-Matic you can conveniently accommodate one-third more draftsmen than with conventional desks and equipment.

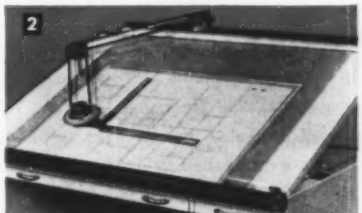
The draftsman needs only to make a half turn in his comfortable, adjustable office chair and there at his finger-tips are shelves for reference material, storage or file drawers and a sliding, Velvoleum covered work shelf. Drawer and shelf arrangement is flexible and can be tailored to individual needs or preference.

Draft-a-Matic not only solves the space problem—it boosts efficiency because the draftsman can perform his entire job while comfortably seated.

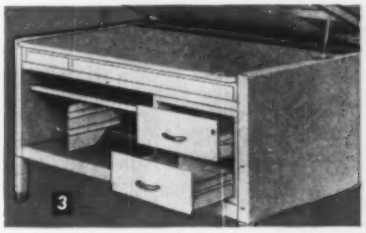
To learn the many ways Draft-a-Matic can help reduce your engineering costs, see it now at your local GF showroom, listed in the Yellow Pages. Or write for free 8-page Draft-a-Matic booklet. The General Fireproofing Company, Department Q-60, Youngstown 1, Ohio.




1. *Drawing is affixed to endless vinyl plastic belt. By merely turning Roto-Positioner wheel, draftsman moves drawing into working range while remaining comfortably seated.*




2. *Draft-a-Matic will accommodate drafting machine, parallel straight edge, lamps and similar accessories. Drawing platform is covered with Mist Green Velvoleum.*




3. *Draftsman is surrounded by storage space so arranged as to serve best his individual requirements. This generally eliminates the need for additional files and book shelves.*

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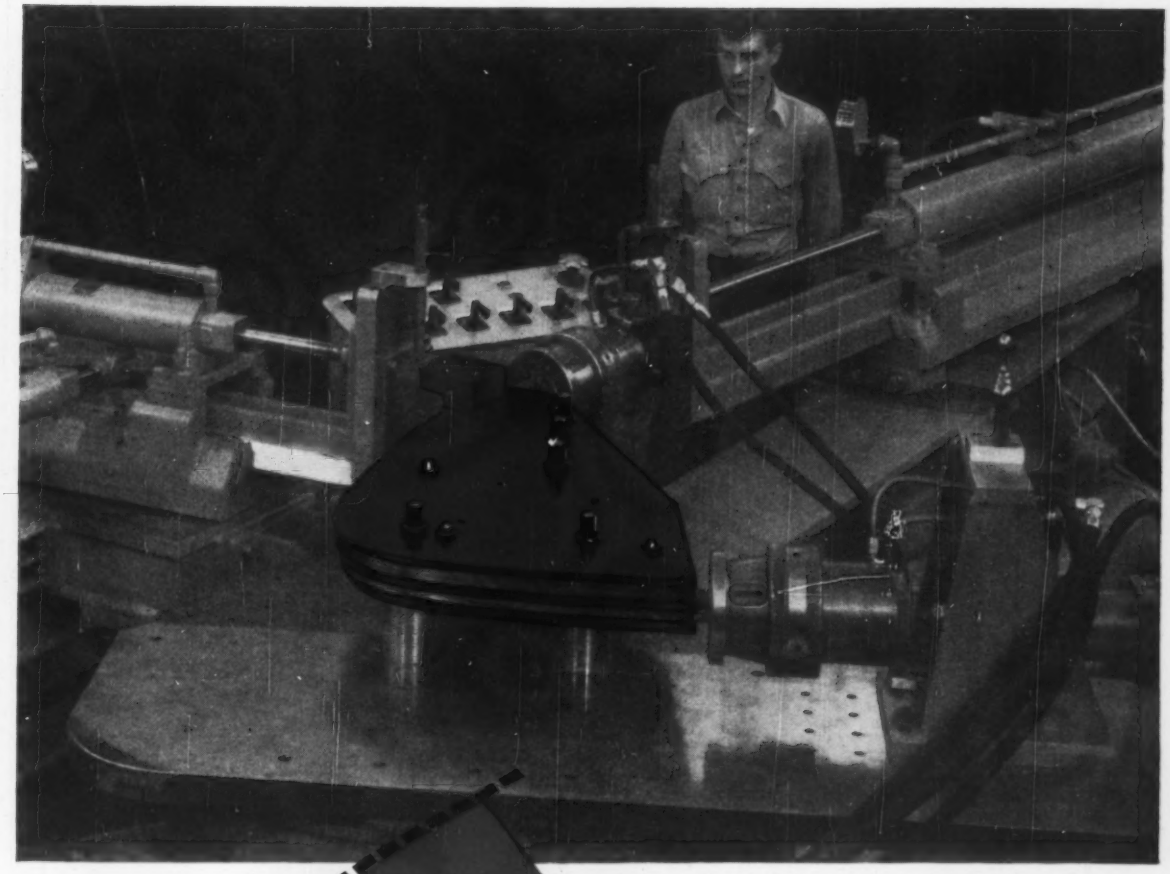

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*(Above) View of Plymouth Engine assembly line*

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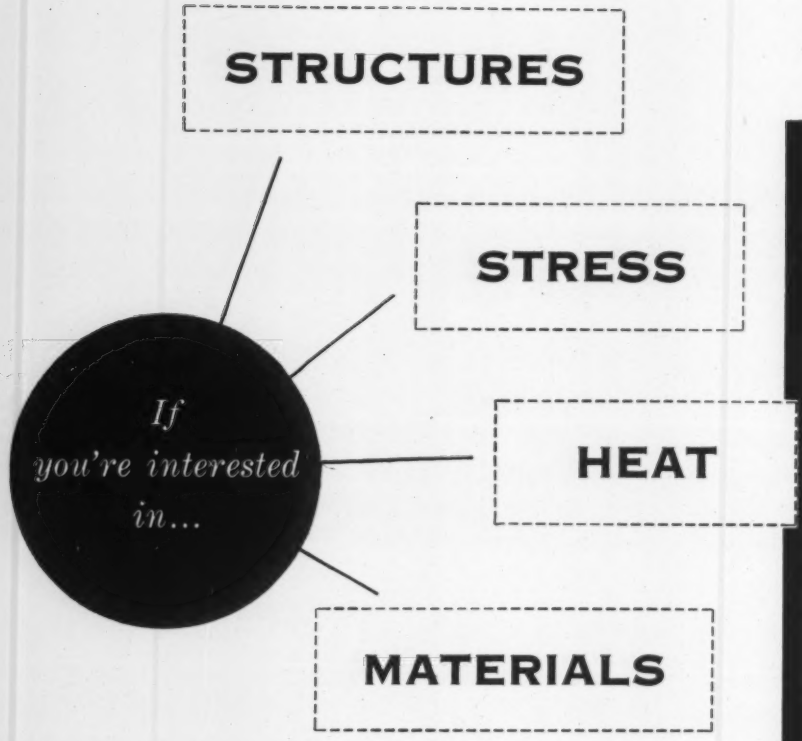


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*These positions also available in the Research and Development activity at Tucson, Arizona.*

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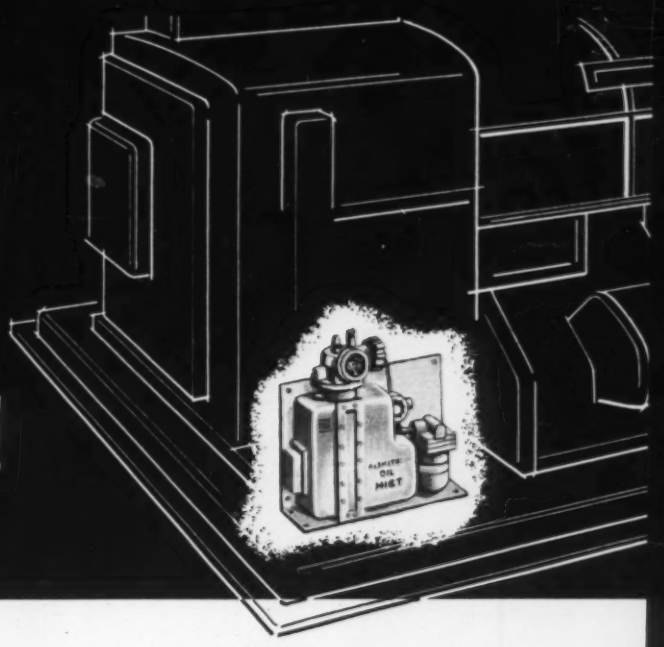

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Alemite Oil-Mist Automatic Lubrication brings remarkable savings . . . in lubricants, man-hours, bearing life, and decreased product spoilage.

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$25 cash prize plus trip to New York for best paper on an engineering subject.

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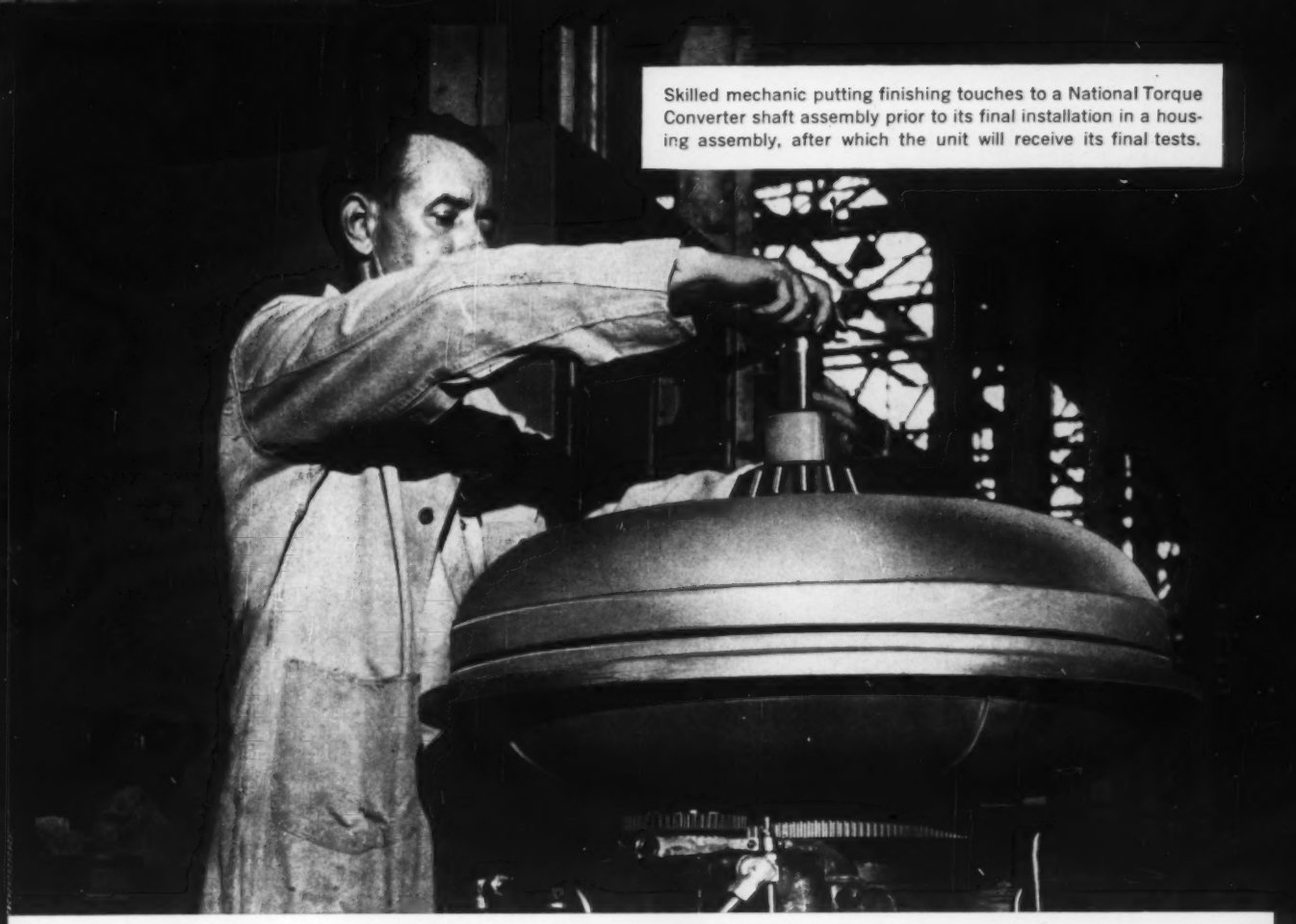
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS



Skilled mechanic putting finishing touches to a National Torque Converter shaft assembly prior to its final installation in a housing assembly, after which the unit will receive its final tests.

# *The National Torque Converter is a dependable "constant horsepower" unit*

Simple design, rugged and durable . . . precision parts assembled by skilled, experienced mechanics . . . standard and special tests of parts, of sub-assemblies, and of completed torque converters

That is why National Torque Converters provide uniformly smooth transmission of power from engine or motor to the job or load. All the shock of quick starting and fast acceleration of the load is absorbed hydraulically by the torque converter. This enables the engine to attain its optimum speed quickly and to deliver its full horsepower constantly . . . and without lugging or stalling.

Result: Job or work cycles will be completed faster and your equipment will deliver more work per unit per operator per day . . . every day . . . with minimum maintenance . . . with extended service life. It can be truly called a "constant horsepower" device.

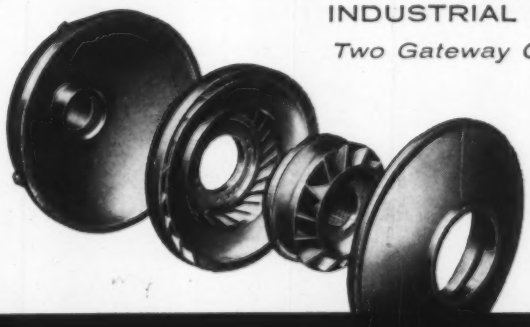
Each National Torque Converter is a complete, integrated unit tailored to the application. And with a choice of 6 basic hydraulic circuit sizes, each with a range of input ratings, the National Torque Converter can be matched exactly to prime movers of 100 to 1000 hp in a wide variety of industrial applications; construction, excavating, drilling, earth-handling, logging, and mining equipment.

Why not let a National Supply engineer study your power-transmission problems and tell you just how National Torque Converters can help you? Or send for a copy of our Bulletin No. 468.

## THE NATIONAL SUPPLY COMPANY

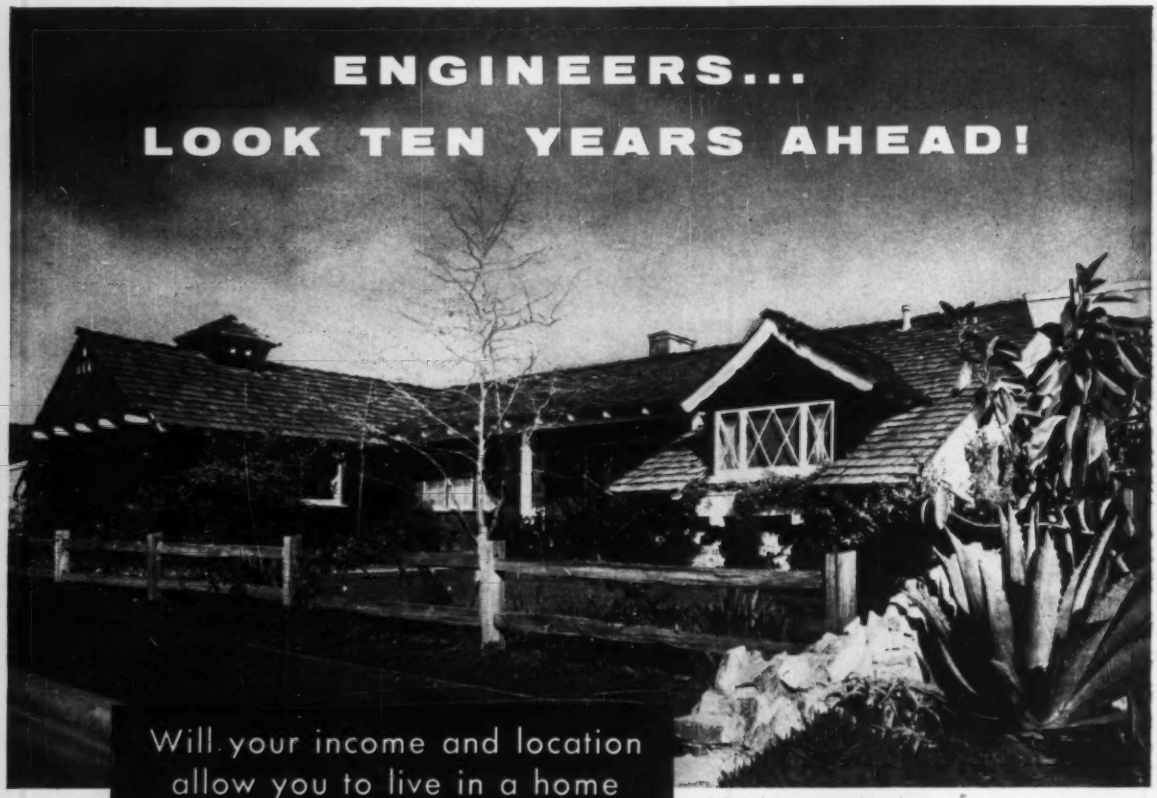
INDUSTRIAL PRODUCTS DIVISION

*Two Gateway Center, Pittsburgh 22, Pa.*



*Pace-setters in the progress of industrial power transmission*

# ENGINEERS...
# LOOK TEN YEARS AHEAD!



Will your income and location allow you to live in a home like this...spend your leisure time like this?

*A Douglas engineer lives here*

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...there's enough scope to the Douglas operation so a man can select the kind of work he likes best!

...there's security in the company's $2 Billion backlog of military and commercial contracts!

...and there's every prospect that in 10 years you'll be where you want to be professionally,

and you'll be in both the income level and geographical location to enjoy life to its full.

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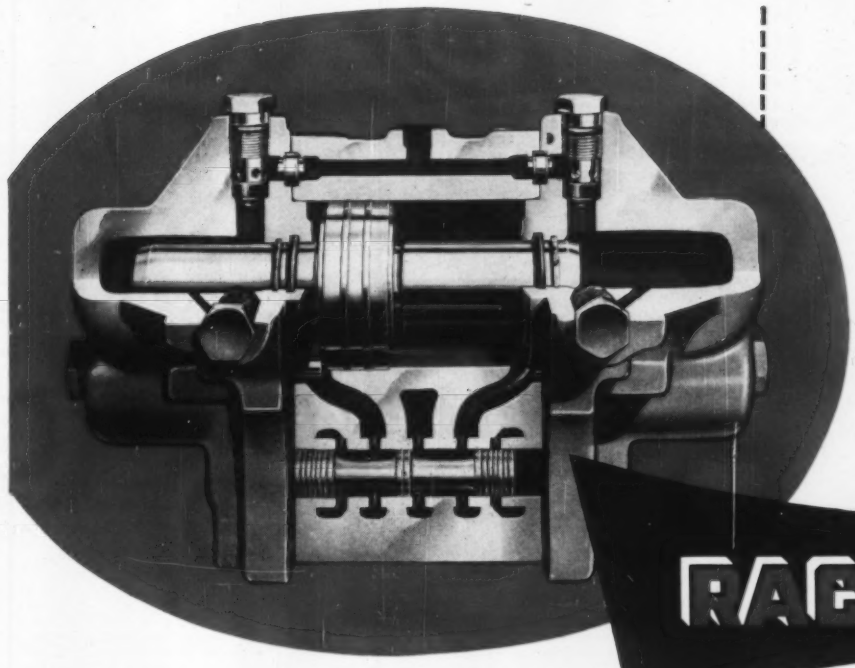

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It allows you to use low pressure at low cost for many operating and closing actions. High pressures to 5000 psi, automatically cut in for final forming and holding operations, or curing cycles on your machine.

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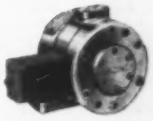

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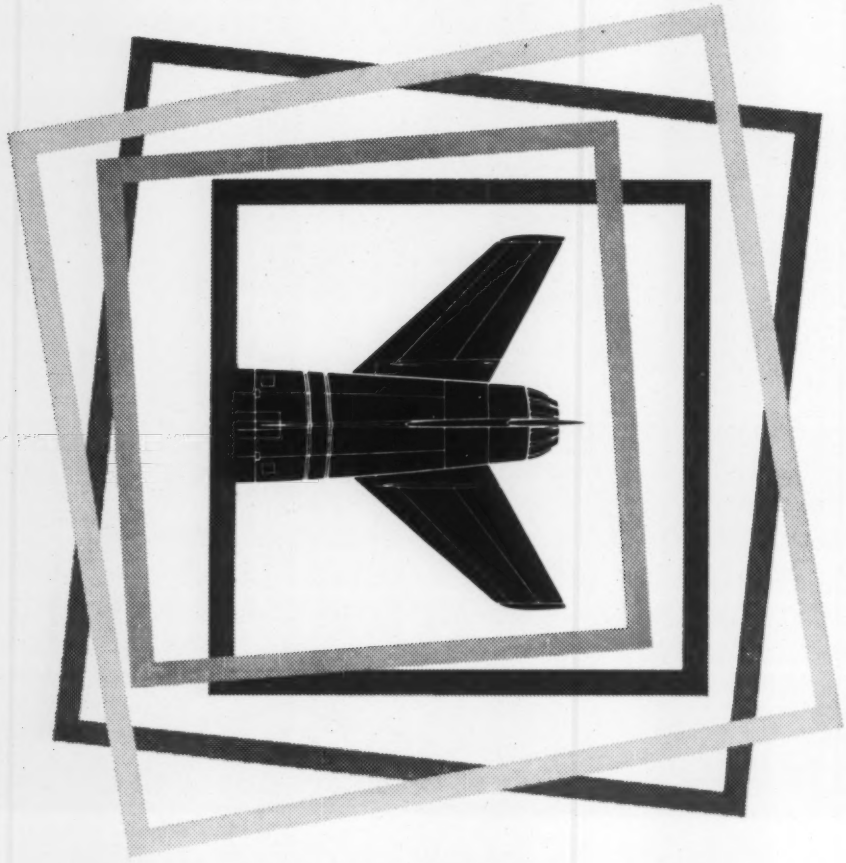

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The opportunities at North American, Los Angeles Division, are many and varied. You work surrounded by activities of a highly interesting nature, using facilities of the most advanced type. You'll enjoy wide scope for your talents, and you'll particularly like the climate of individualism and team spirit that exists. Your associates will be people who respect your opinions and professional status. Check the openings listed below.

**OPENINGS ARE IMMEDIATE. PROFESSIONALLY QUALIFIED WOMEN ARE WELCOME**

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**ALSO NEEDED:** Aerodynamicists, Systems Engineers, Instrumentation Engineers, Aero-Thermodynamicists, Aeroelastic Engineers, Cycle Analysis Engineers

**Contact Les Stevenson, Engineering Personnel Office, Dept. 56-11 ME**
**North American Aviation, Inc., Los Angeles 45, California**

**North American Aviation, Inc. is doing research and development on the X-15, a manned aircraft for investigation of speeds and temperatures at very high altitudes.**

Los Angeles Division

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Despite the relatively wide extent to which oil – and gas – have come into use for firing industrial boilers, the fact remains that coal continues to be the most economical fuel available in many areas.

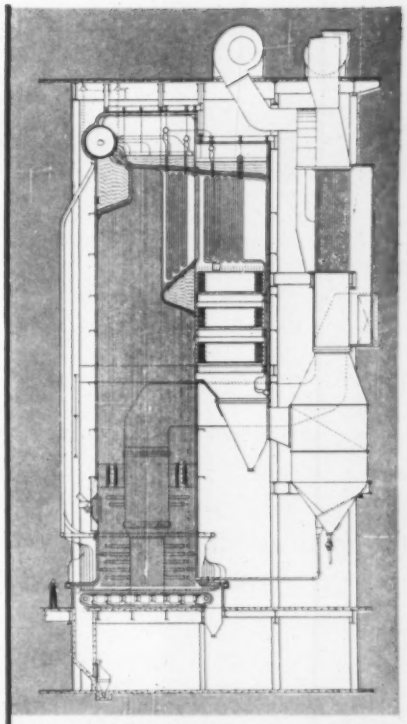
Moreover many potential coal users are unaware of the tremendous improvements that have been made in recent years in the design and general effectiveness of mechanical stokers. Here at Combustion virtually the entire stoker line has had extensive design changes, all directed at improved performance. But overall performance is tied in inescapably with boiler performance. At Combustion you have the important advantage of dealing with a leading boiler manufacturer that also offers the most complete line of stokers available anywhere. You are assured, therefore, of a completely coordinated design comprising stoker, boiler, furnace and – if desired – heat recovery equipment and/or auxiliaries, all engineered specifically for your particular requirements.

Displayed below are three – of the many – C-E stoker-fired boiler designs which, collectively, are suitable for any coal-firing conditions.

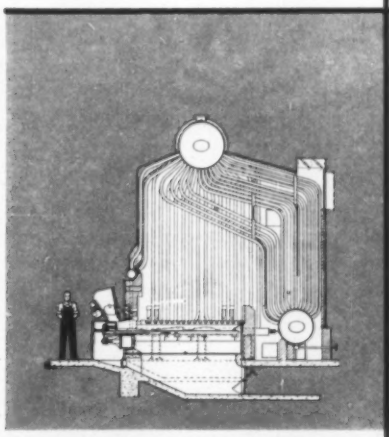
At the right is illustrated the latest – and largest – example of the C-E Bark-burning Unit, a design pioneered by Combustion and now widely used for burning bark, hogged-wood and other waste wood fuels.

So – when you are in the market for coal or other solid-fuel-burning units it will certainly be to your advantage to find out what Combustion Engineering has to offer. Our engineers will be glad to discuss your needs with you or your consultants.

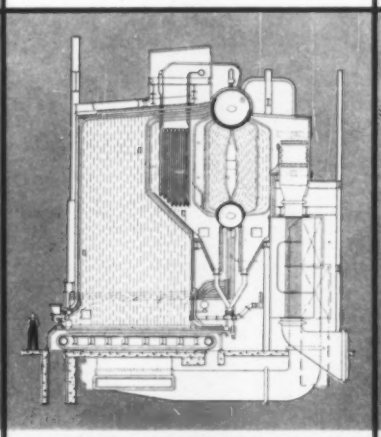
B-892A



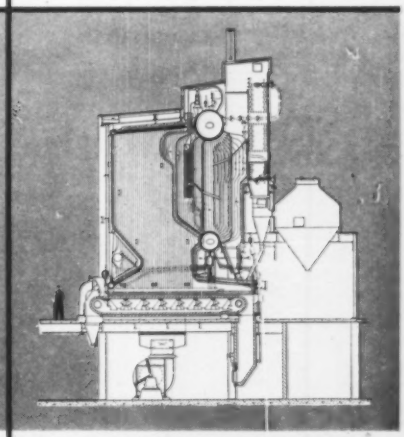
**C-E BARK-BURNING UNIT** for a paper company. This is a very large unit; capacity – 450,000 lb steam per hr, operating pressure – 1335 psig; total steam temperature – 958 F. It is designed to burn bark, natural gas, oil or any combination thereof. These units are in service for capacities as low as 20,000 lb of steam per hr.



**THIS C-E VERTICAL-UNIT BOILER, TYPE VU-10** fired by a C-E Underfeed Stoker, Type E is for a dairy. Capacity is 30,000 lb steam per hr at 150 psig. VU-10 Boilers are available for capacities from 10,000 to 60,000 lb of steam per hr. They are often equipped with C-E Spreader Stokers, dump grate type.



**ONE OF TWO DUPLICATE UNITS** for a chemical company comprising C-E Vertical-Unit Boilers, Type VU-40 fired by C-E Spreader Stokers, continuous discharge type. These are baffleless boilers designed for a capacity of 150,000 lb steam per hr at 900 psig and 808 F. Coal is Eastern Bituminous.



**THIS C-E UNIT** is being installed for a soap company. It comprises a C-E Vertical-Unit Boiler, Type VU-50 fired by a C-E Traveling Grate Stoker. Coal used is Midwest Bituminous. This boiler is designed for a capacity of 100,000 lb steam per hr at 850 psig and 585 F. It is an outdoor type unit.

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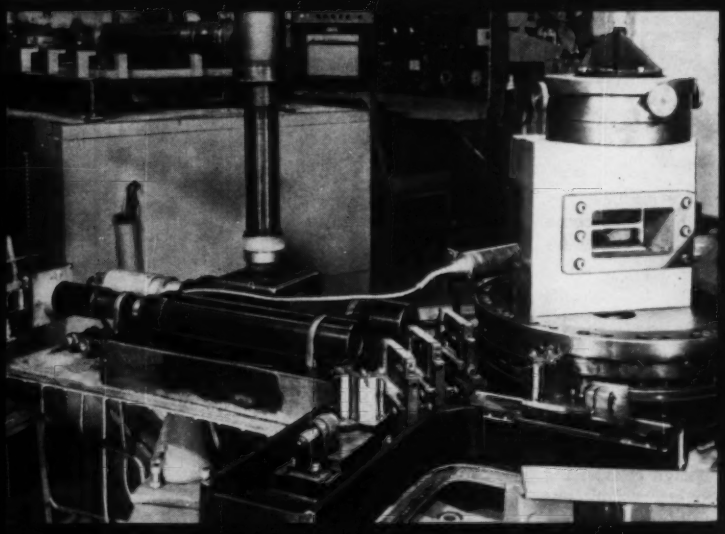
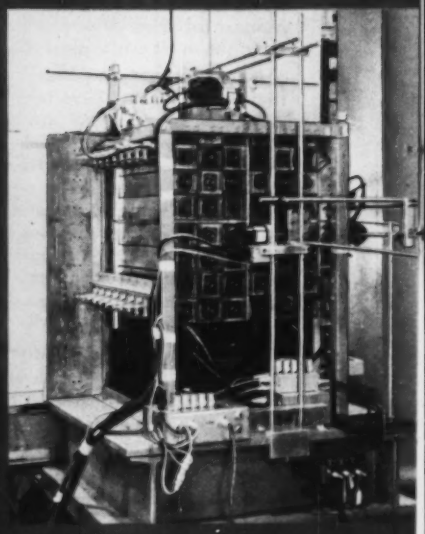


**BASIC RESEARCH**

The crystal table and the optical system of the 7.7 meter bent crystal gamma-ray spectrometer.

**ENGINEERING DEVELOPMENT**

Argonne National Laboratory Fast Exponential Assembly showing 5:1 ratio, 10 fuel plates and 5 dilution plates per fuel can.



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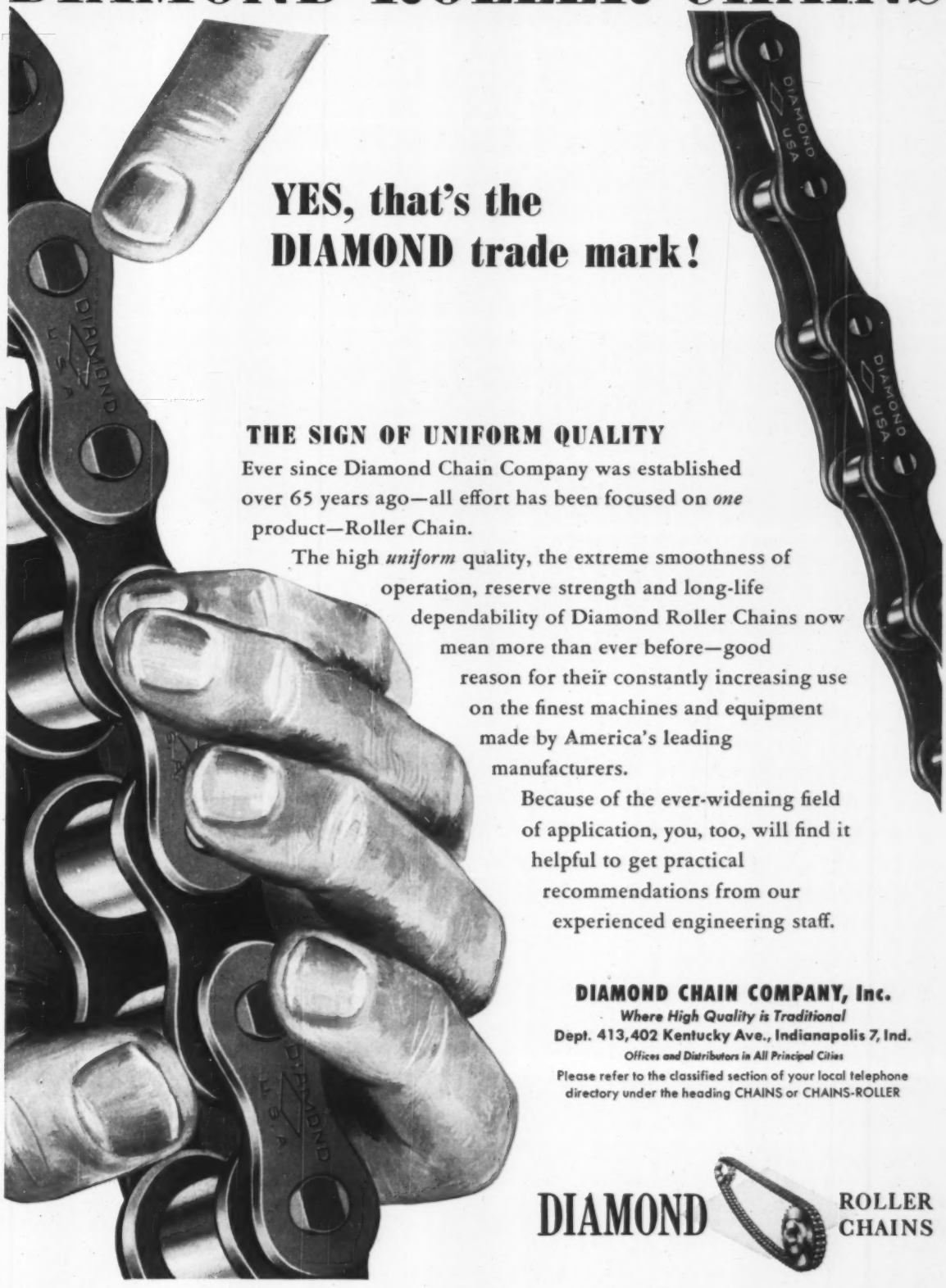


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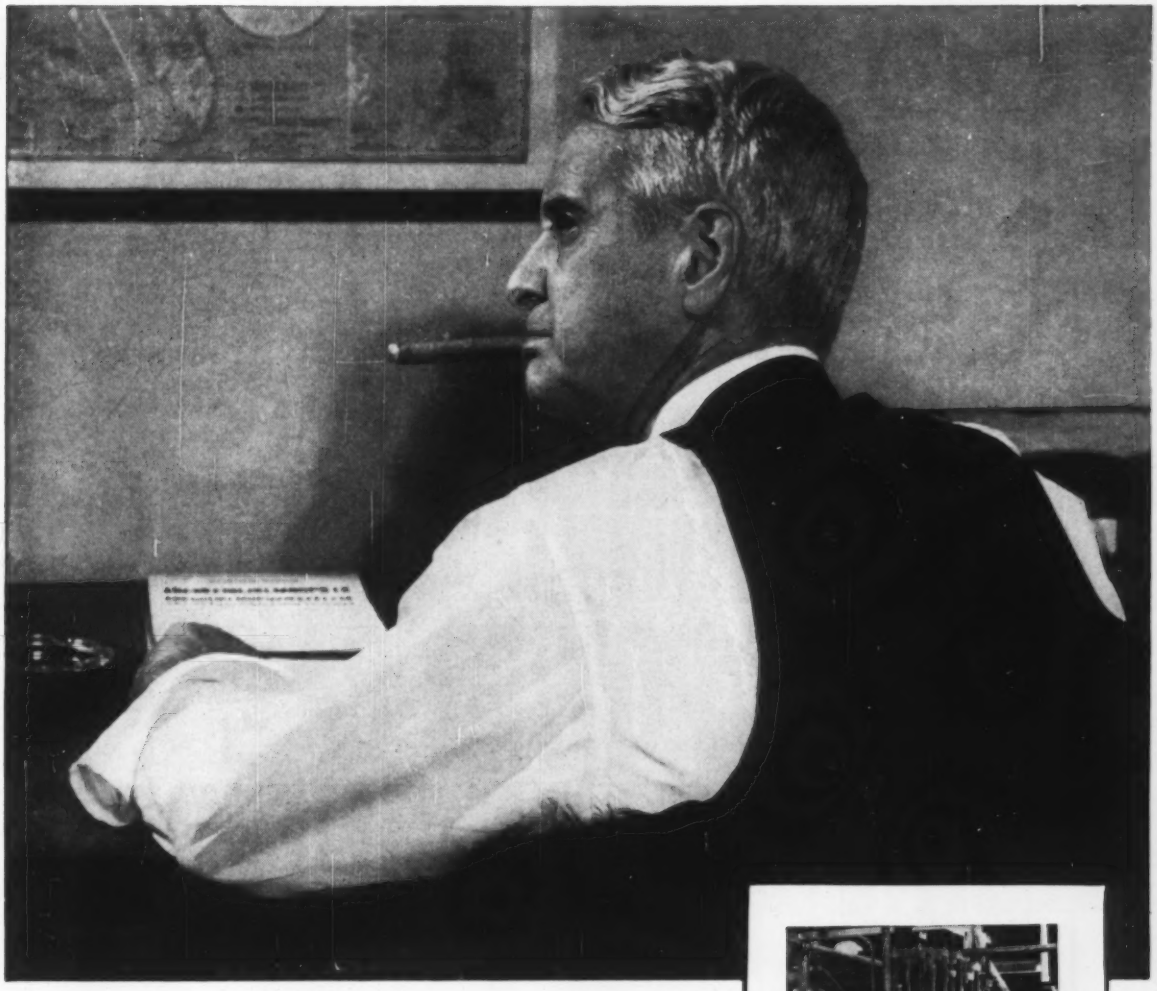

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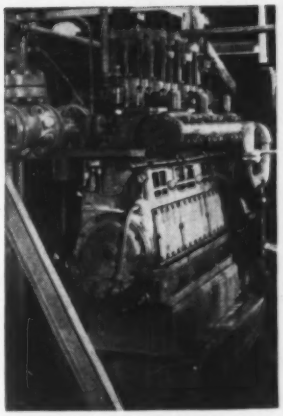
The heart of any central hydraulic system is the pump. And if the pump is an Aldrich you can be sure of 100% availability of hydraulic power, with either oil or water.

The very simplicity of the Aldrich Direct Flow design means horizontal straight line flow from suction to discharge. Reduced space between valves results in higher volumetric efficiency. Fluid-end sectionalization for fast, easy maintenance; changeable plunger sizes; and interchangeability of parts are additional reasons why Aldrich Pumps have earned a reputation for dependable, low cost performance on applications such as die casting, hydraulic press operation, roll balancing, descaling and hydraulic testing.

For your tough pumping problems, it pays to specify Aldrich. Write today for a copy of Data Sheet 100, a condensed catalog and selection chart covering our entire line. The Aldrich Pump Company, 29 Pine Street, Allentown, Pa.



Four 5" stroke Aldrich Direct Flow Pumps on die casting service in a midwestern metalworking plant. These pumps are handling 250 gpm at 1500 psi.

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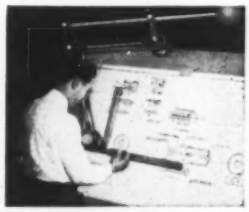
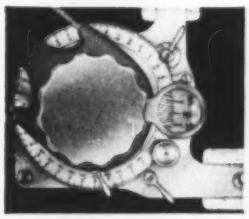
# "And I Said I'd Never Use a Drafting Machine"

## *"That Was Before I Tried a Bruning Equipoise Drafter!"*



Bruning Counterbalanced Drafters and Bruning Track Drafters provide fast, easy, accurate drafting on vertical boards and on extra-large drawings.



Bruning Equipoise Drafters are available with either the Civil Engineer protractor head, shown here, with its special azimuth scale, or the Standard protractor head.

Take a tip from an increasing number of draftsmen who, perhaps like yourself, were reluctant to try any drafting machine or had been disappointed in a conventional type drafter. These men now report: Bruning Equipoise Drafters cut drafting time over conventional equipment up to 40% on most jobs, up to 50% on some structural drawings — beat any other drafting machine they ever tried.

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If you qualify in one of the fields we have listed below, chances are you can qualify for this unique expedition into the technology of the future. We would like to tell you about all the physical and professional advantages of a career in North American's Missile Development Engineering.

**Please contact us for the full story:**

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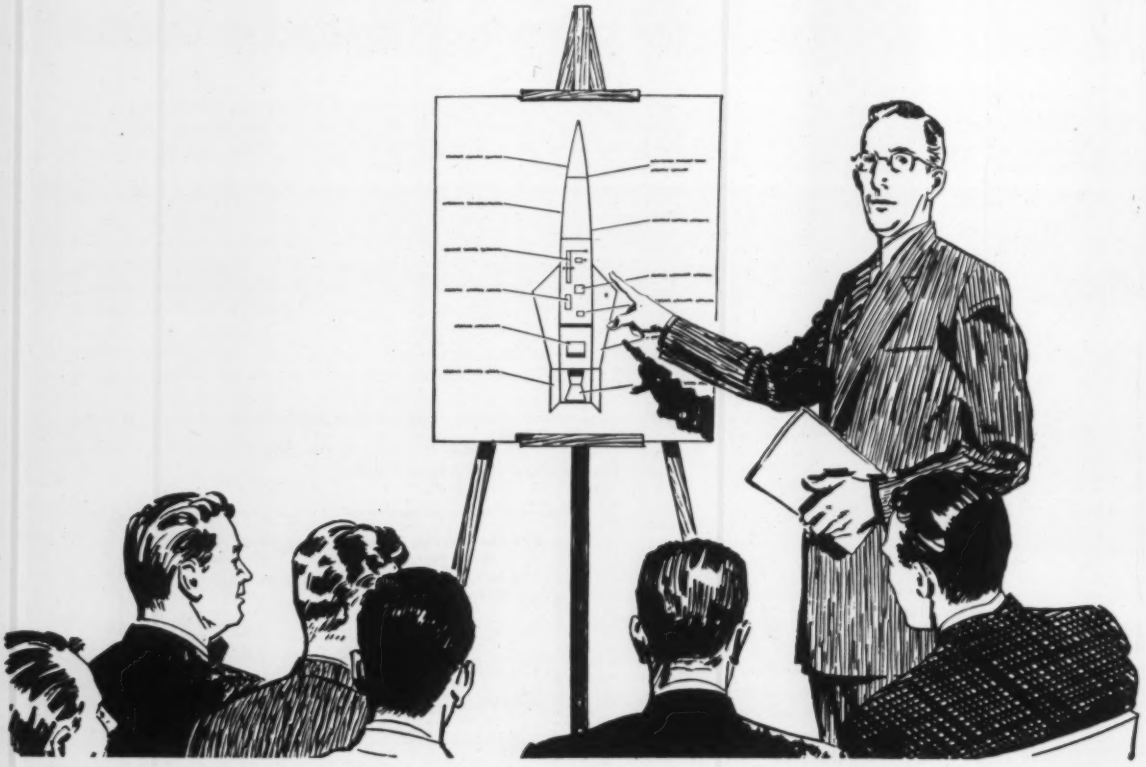
**Contact:** Mr. M. Brunetti, Missile Engineering Personnel
Dept. 91-11ME, 12214 Lakewood Boulevard, Downey, Calif.

## NORTH AMERICAN AVIATION, INC.



**FOR COMPLEX FABRICATION.** In chemical plants, these Stainless Steel acid catchers are used to remove dilute sulfuric acid from gases. Continental Boiler & Sheet Iron Works in St. Louis fabricated the units. Notice the complicated curves in the helix plates, and the neat joinery . . . a tribute to fine craftsmanship and the workability of Stainless Steel.

**FOR ABRASION AND CORROSION RESISTANCE.** Oil can racks stand out in all kinds of weather, and the support strips are constantly rubbed and knocked by the heavy cans of oil. Modern Metal Products Company of Greensboro, N. C. makes the strips out of Stainless Steel so they will stay bright and new-looking, and never get banged out of shape.

# NOTHING *can equal* *Stainless Steel*

*In its combination of desirable properties*

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When seeking a source of supply, remember that United States Steel offers you the widest range of types, finishes and sizes.

**FOR SANITATION.** These Stainless Steel shelves are made by the Eastern Steel Rack Company, Boston, Massachusetts, for use in cold storage rooms. They are easy to clean, and offer a sanitary, corrosion-resistant surface for food products of all kinds.

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UNITED STATES STEEL

Denver Post photo

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**New Zallea Duo Equalizing Expansion Joints** represent a major advance in expansion joint design. Years of continuous research have resulted in an expansion joint that lasts longer, is substantially smaller and lighter, and has greater stability than any other available expansion joint.

**Longer life.** Hundreds of cycling tests to destruction prove that Duo Equalizing Expansion Joints last as much as 40% longer than Self Equalizing Expansion Joints at the same pressure and movement.

**Lighter weight.** Weight of the expansion joint has been reduced as much as one-third. Handling and installation are easier.

**Shorter length.** Overall length has been reduced as much as 30%.

**Greater stability.** Reduction in ratio of length to diameter means higher stability at high test pressures —no need to support the expansion joint to prevent buckling during hydrostatic testing.

**Sizes and traverses.** Sizes range from 3″ diameter to 72″ diameter, for traverses up to 7½″ in a single unit or 15″ in a double unit.

**Working pressures.** Although normally intended for 150 and 300 psig working pressures, Duo Equalizing Expansion Joints can be designed for higher pressures.

**Service.** The Duo Equalizing Expansion Joint is preferred for all outdoor piping systems subjected to atmospheric temperature changes—as well as for institutional and other services that operate on frequent on and off cycles.

**Get the complete story** of the new Zallea Duo Equalizing Expansion Joint in our newly published 72-page Zallea Expansion Joint Manual. Write today, on your Company letterhead, for your copy of Catalog 56. Zallea Brothers, 820 Locust Street, Wilmington 99, Delaware.

*Zallea*
*expansion joints*

Zallea Brothers, Wilmington 99, Delaware • World's largest manufacturer of expansion joints

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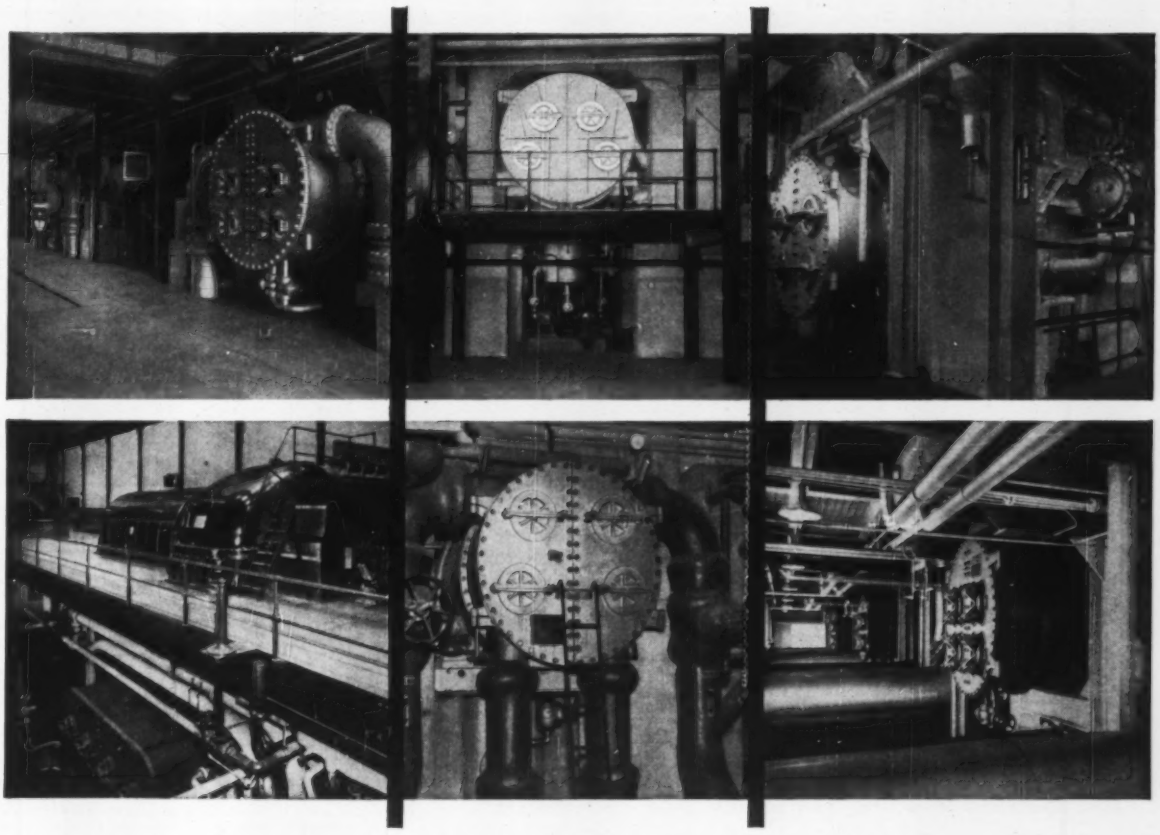
## *serve power plants everywhere*



Pre-eminence of Ross engineering and manufacturing has won many customers . . . and kept them . . . here and abroad.

Public utilities, municipalities, industries, institutions, office buildings . . . some equipped with large twin bank designs, others with smaller single bank units . . . number among Ross installations which date back 40 years.

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# Check This Check Valve
## *and keep your troubles in check*

**Chapman TILTING DISC Check Valve**

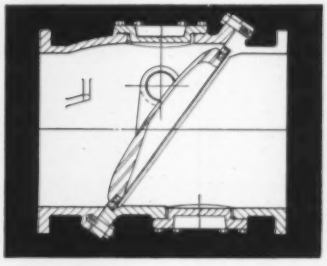
Everything works in your favor.

With Chapman's Tilting Disc Check Valve there's no vibration, no fluttering, no noise. There's no slamming, with usual piping arrangements, no banging to cause damage to system or valve. There's no grinding, scraping or wearing to either the disc or seat.

All of this means less headaches to you . . . both physical and financial headaches. The smooth, sure, quiet action means less, much less, maintenance over the longest period under toughest operating conditions.

Chapman Tilting Disc Check Valves with money-saving advantages like these are available in iron and steel, with standard end to end, for handling fluids or gases under a wide range of pressures. They're listed and shown in our Catalog 30-A. Send for it and check the valves you need for replacement or new piping systems, right now.

**The CHAPMAN Valve Mfg. Co.**
INDIAN ORCHARD, MASSACHUSETTS



**The Valve That Goes with the Flow**

Here's the idea in back of it all. When the flow is on, "airfoil" disc is held firmly against stops in the body. When the flow drops, disc balances itself quietly on whatever flow there is. When the flow stops, disc drops quickly and tightly on special bevel seat. It's as simple as that. It's as sound as that. And valve men will be pleased when they see that enough room is given around disc to cut down flow resistance.

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On the other hand, if you realize that all the bright promises and special inducements in the world cannot alter the fact that hard work, ability, and the drive to apply them are the things that make and seize real opportunities—you'd do well to read on.

Don't get the idea, because of the foregoing, that we underrate ourselves in any way. Quite the contrary. We know that our work—design and development of nuclear weapons—is as important as any being done today. We know that our working conditions and employee benefits are second to none. We know that we provide real opportunities for growth and advancement—for qualified people who have what it takes. We know, too, that living conditions at our locations—in terms of climate, housing, schools, recreation, and cultural facilities—are hard to match anywhere. At the same time, we know that it's up to you to decide whether or not you agree with us. We also have the idea that it's up to you to convince us of your ability.

If you'd like to know more about us—our work, our background, and both our laboratories, one in Albuquerque and one near San Francisco, we'll be happy to send you our illustrated brochure that tells the whole story. Just write to Staff Employment Division 553.

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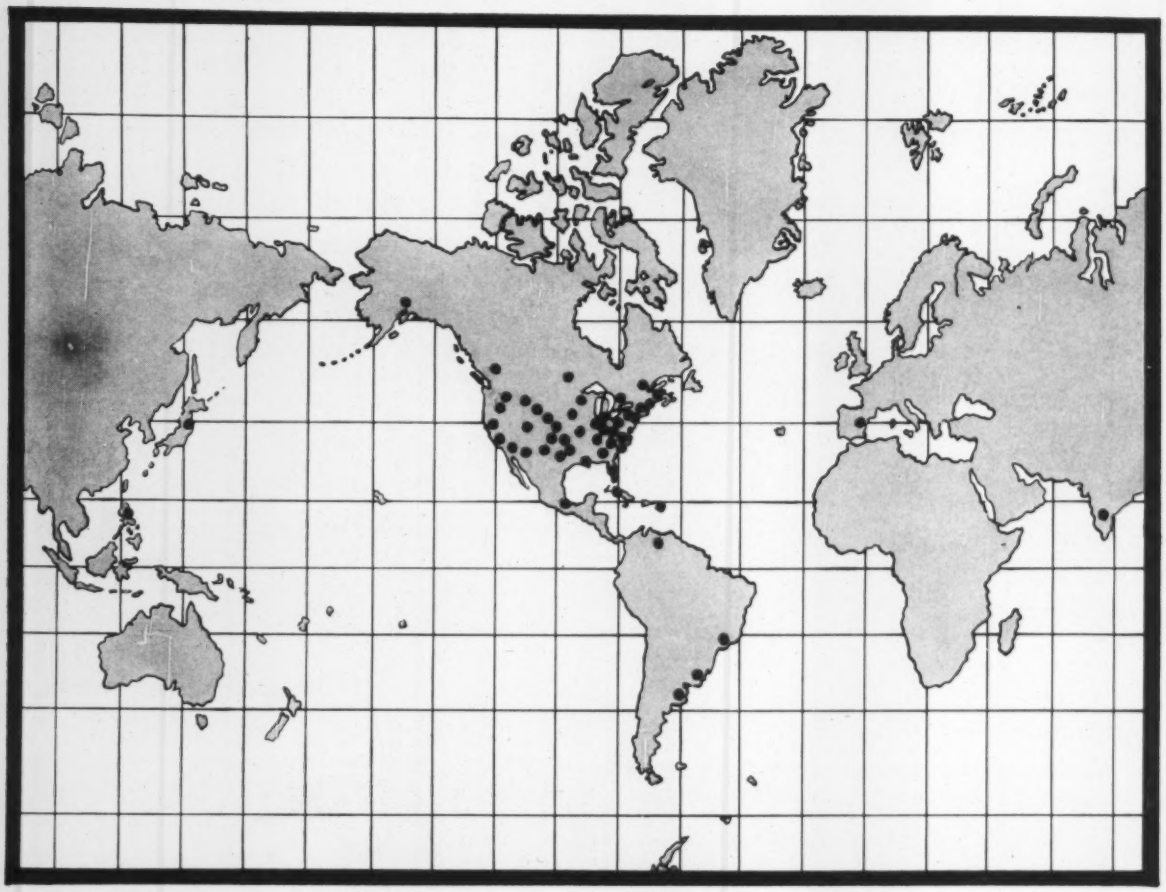

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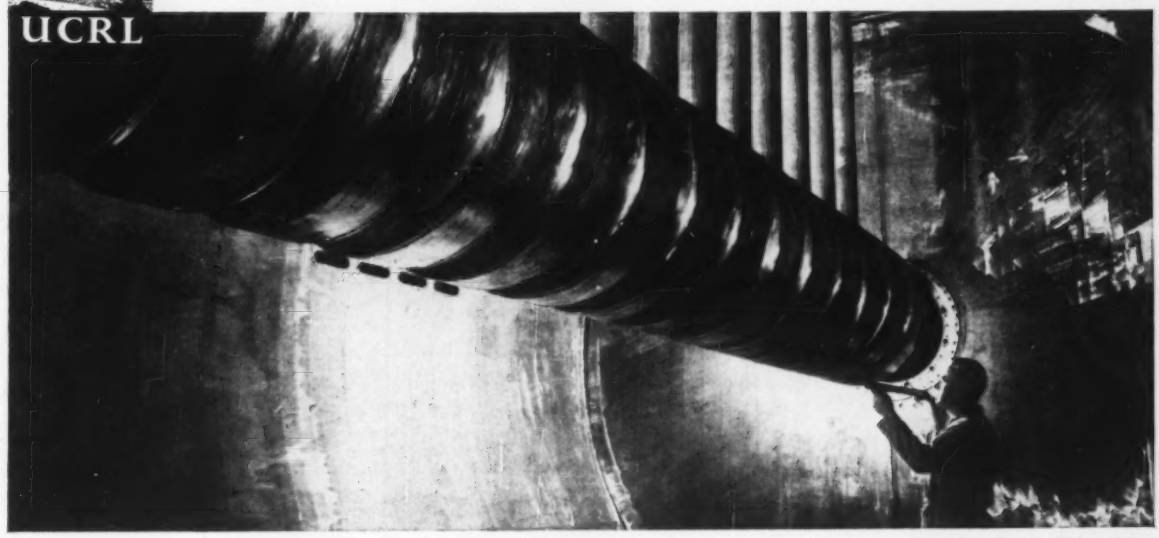

At UCRL's Livermore, California, site—interior view of drift tubes in high-current linear accelerator designed to deliver 250 ma of 3.6 Mev protons or 7.8 Mev deuterons

# Could *you* help advance these new frontiers?

**New techniques... new equipment... new knowledge—all are in constant growth at Livermore and Berkeley, California as some of America's most challenging nuclear frontiers are met and passed by the University of California Radiation Laboratory's unique scientist-engineer task force teams.**

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*Observe, compare and measure two related AC or DC signals with the new, high precision*

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## CATHODE-RAY OSCILLOGRAPH

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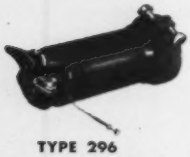
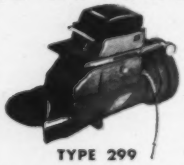


**TYPE 296**

Versatile, economical 35 mm general-purpose oscillograph record camera with f/2.8 lens. Price $149.50



**TYPE 299**

General-purpose recording camera accepts variety of backs for 120 size roll film, cut film or film pack; inexpensively converted into print-a-minute Polaroid Land camera. Price $265.00

**TYPE 302**

For permanent records in just a minute with Polaroid-Land back; by simple, inexpensive change of backs can be adapted for general-purpose recording with other than Polaroid films. Price $285.00

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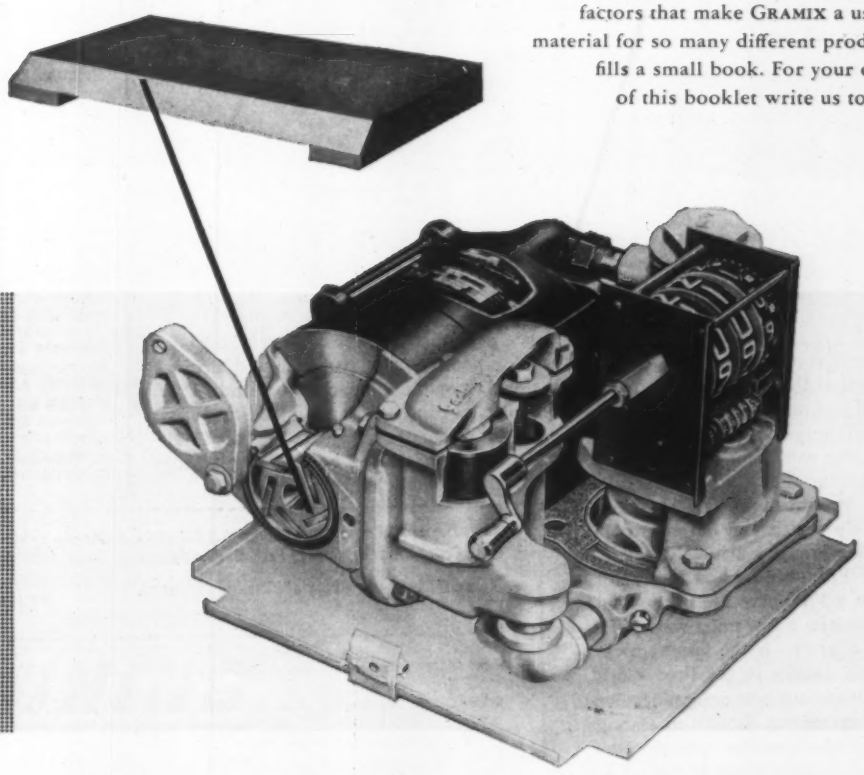
Continuous motion or single-frame recording on 35 mm perforated or unperforated film or recording paper; film speeds variable in steps from 0.8 to 3600 inches/minute. Price $1050.00

**DU MONT** TECHNICAL PRODUCTS DIVISION
Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

# GRAMIX® vanes in Gasboy® pump wear only .031" per ONE MILLION GALLONS

The Gasboy Super "200" gasoline pump is manufactured exclusively for farms, fleets, and industry by Wm. M. Wilson's Sons, Inc. in Lansdale, Pa. These pumps have proven to be accurate, efficient and dependable. But, what naturally interests us and will interest you, as a manufacturer or designer, are the GRAMIX vanes in these pumps. Tests reveal that the GRAMIX Grade 41 vanes still operated perfectly after pumping over 1,000,000 gallons of gasoline. During this endurance test, the vanes travelled around the inside of the housing a distance equal to 13,000 miles, or more than half way around the earth!

Not only these particular vanes, but hundreds of other GRAMIX parts are doing a successful job in appliances, aircraft, automobiles and an amazing variety of products. GRAMIX parts are die-pressed to close tolerances, and need no machining. They are strong, they are self-lubricating. The many factors that make GRAMIX a useful material for so many different products fills a small book. For your copy of this booklet write us today.



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## THE UNITED STATES GRAPHITE COMPANY

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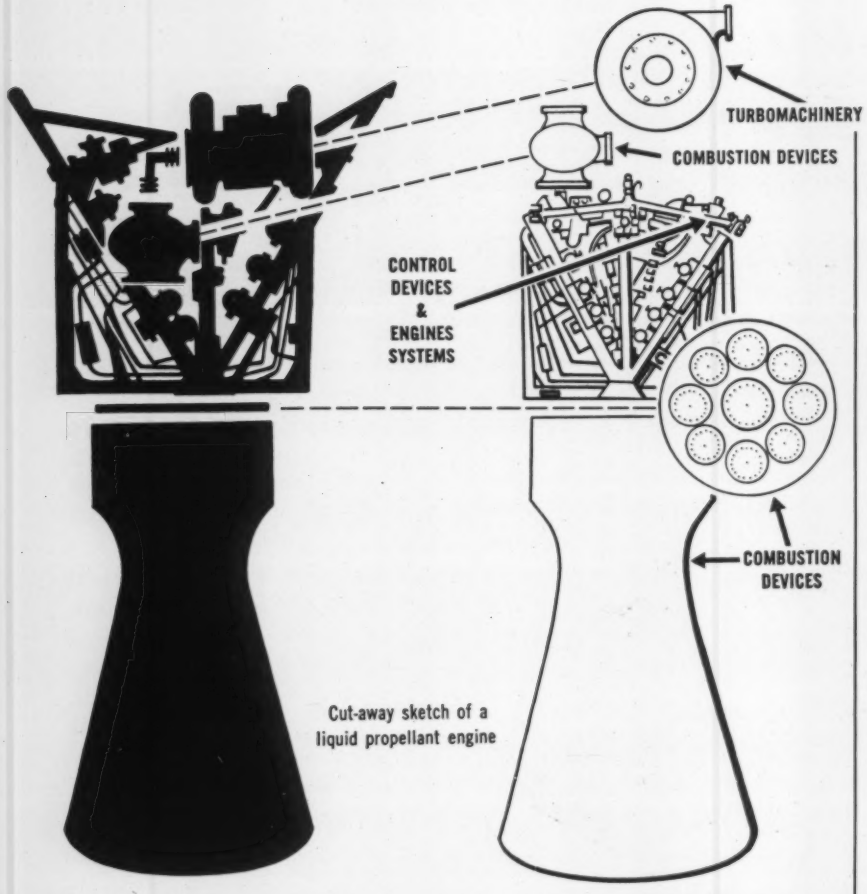


Cut-away sketch of a liquid propellant engine

**Turbomachinery**
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Hydrodynamics
(Centrifugal & axial flow pumps)
Stress Analysis
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for high speed turbines, pumps, gearing, bearings, rotating seals.

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Combustion System
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**Engine Systems**
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Systems Design
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Pneumatic Systems
Hydraulic Systems

# R & D Engineers: can you fit into this picture?

Chances are that one of the areas of engineering listed at the right will fit you like a glove! All you need be is a research, development or design engineer with a desire for challenging work and pertinent background experience.

ROCKETDYNE needs men with special talents to help design and develop rocket engines for long-range and intercontinental missiles. Its Propulsion Field Laboratory—located on a 1700-acre site in the Santa Susana Mountains a few miles west of Los Angeles, California—is the largest rocket engine testing facility in the Free World. Here, and also at our new design, development and engineering facility in Canoga Park, you will find the rewards of leadership—good salary, personal and professional recognition, exciting work and secure future. For the full story on ROCKETDYNE, send for your *free* copy of "The Big Challenge"—a fact-filled booklet explaining Rocket engines and engineering.

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Degree_____ Year_____

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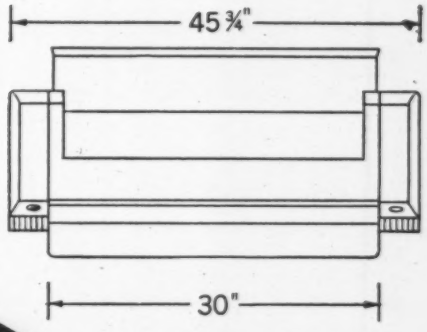
**ROCKETDYNE**
A Division of North American Aviation, Inc.

BUILDERS OF POWER FOR OUTER SPACE

# At Last! A Small Whiteprinter that Makes BIG Prints!




**FULL 30-INCH PRINTING WIDTH!**

# NEW! BRUNING Copyflex Model 300!

**Brings "Inside" Reproduction within the Means of the Smallest Engineering Firm or Department!**

Now, with your low-cost, versatile Model 300, you can make high quality prints when you want them—rapidly, privately, and in any quantity. You can exercise complete control over valuable originals at all times.

**Provides Large Companies an Economical Way to Supplement Main Reproduction Centers!**

With its compact size, big printing width, and low cost, the Model 300 is an ideal helper for your big reproduction machine. Strategically located throughout your company, Model 300s can bring new speed, convenience, and efficiency to your reproduction operations.

Here it is! The compact, low-cost reproduction machine that offers all the versatility and big printing width of a large, expensive whiteprinter!

Just think—you can make sharp, black-on-white prints in seconds of a drawing or tracing up to 30 inches wide by any length. And anyone can operate the Model 300 after only brief instruction. One fingertip control turns the machine on or off, and regulates its speed. Exposure and development are automatically synchronized.

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If you're pressed by the boom in production for more and more engineering prints, the all-new Copyflex Model 300 is your answer! Its low initial cost combined with outstanding economy and convenience of operation and maintenance make it your soundest, low-cost investment of the year. Mail coupon today! You'll be glad you did!

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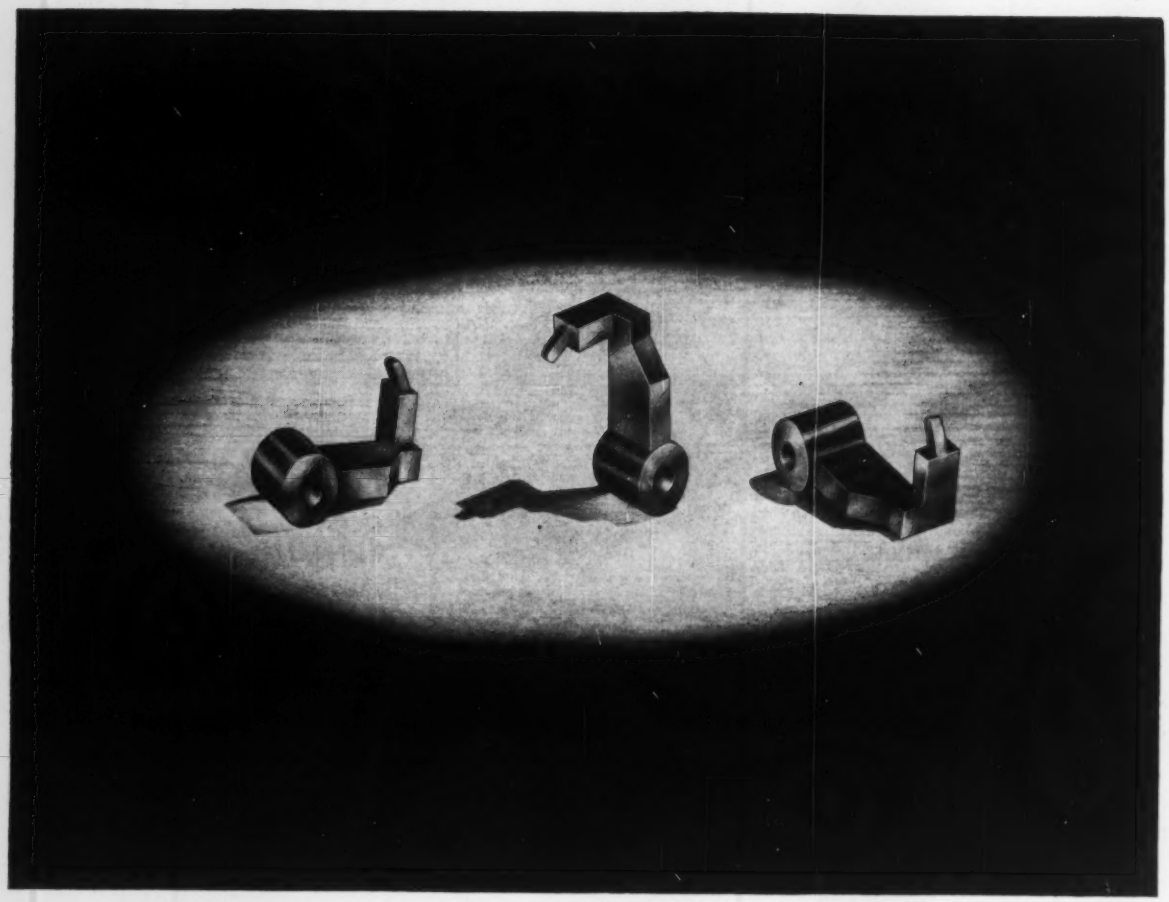

# Impossible in Powdered Metal? Not at PARKER

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**SALES ENGINEERS**

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Edward F. Higgins, Jr. • 102 West Adams Street

**WILTON, Conn.**
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**SYRACUSE, N. Y.**
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This part—with projections in several planes, not to mention an I.D.-O.D. section—looked like an impossible job for powdered metal. Yet Parker made it in **one press operation**—complete—to close tolerances and tight "specs"—at relatively **low cost.**

This unusual piece points up the advantages offered by Parker powdered metal processing. Tough cost problems of conventional casting and machining methods often can be solved. Tensile strength, ductility and impact resistance can be closely controlled to meet rigid specifications. Powdered metal constituents can be precisely and uniformly blended for a wide range of requirements.

Parker's experience and facilities in producing a wide variety of powdered metal parts have saved money—and solved problems—for many users. Your problem may be one that Parker can solve in like manner. Just call the nearest Parker sales engineer listed at the left.

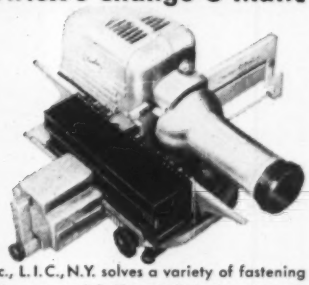
**Parker White Metal Company • 2153 McKinley Ave., Erie, Pa.**

**PARKER**

**POWDERED METAL PARTS**
**ALUMINUM and ZINC die castings**

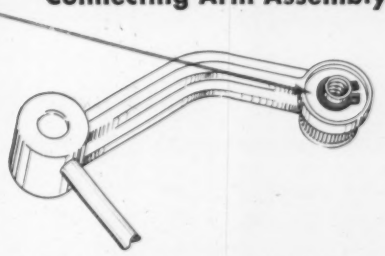
# Waldes Truarc Rings Permit Better and More Economical Design—Fewer Parts, Faster Assembly, Minimal Rejects!

### Viewlex's Change-O-Matic



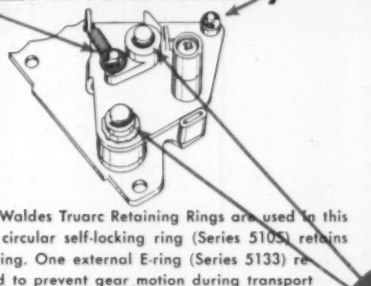
Viewlex, Inc., L.I.C., N.Y. solves a variety of fastening problems in their new model Change-O-Matic automatic slide changer. Assembly time is speeded, parts eliminated, rejects lowered, and compact, economical product design achieved.

### Connecting Arm Assembly



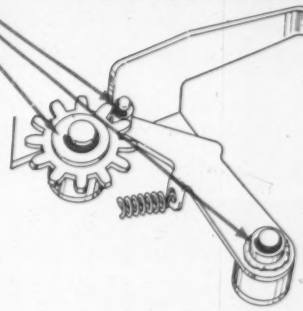
Use of one Waldes Truarc Ring (Series 5100) eliminates time-consuming riveting over the flange, retains and holds the connecting knob captive. A compact, neat design is made possible, rejects caused by poor riveting eliminated.

### Actuating Plate and Pawl Assembly



Three types of Waldes Truarc Retaining Rings are used in this assembly. One circular self-locking ring (Series 5105) retains pawl return spring. One external E-ring (Series 5133) retains roller used to prevent gear motion during transport cycle. One crescent ring (Series 5103) retains pawl which indexes gear. Second crescent ring retains sub-assembly. Truarc Rings speed assembly, cut rejects, eliminate parts.

### Detent Lever Assembly



Truarc E-ring (Series 5133) eliminates use of tapped hole and shoulder screw, retains roller which prevents over-travel of gear. Assembly is rapid.

**Whatever you make,** there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

**36 functionally different types**... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

**More than 30** engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

**WALDES**

# TRUARC®

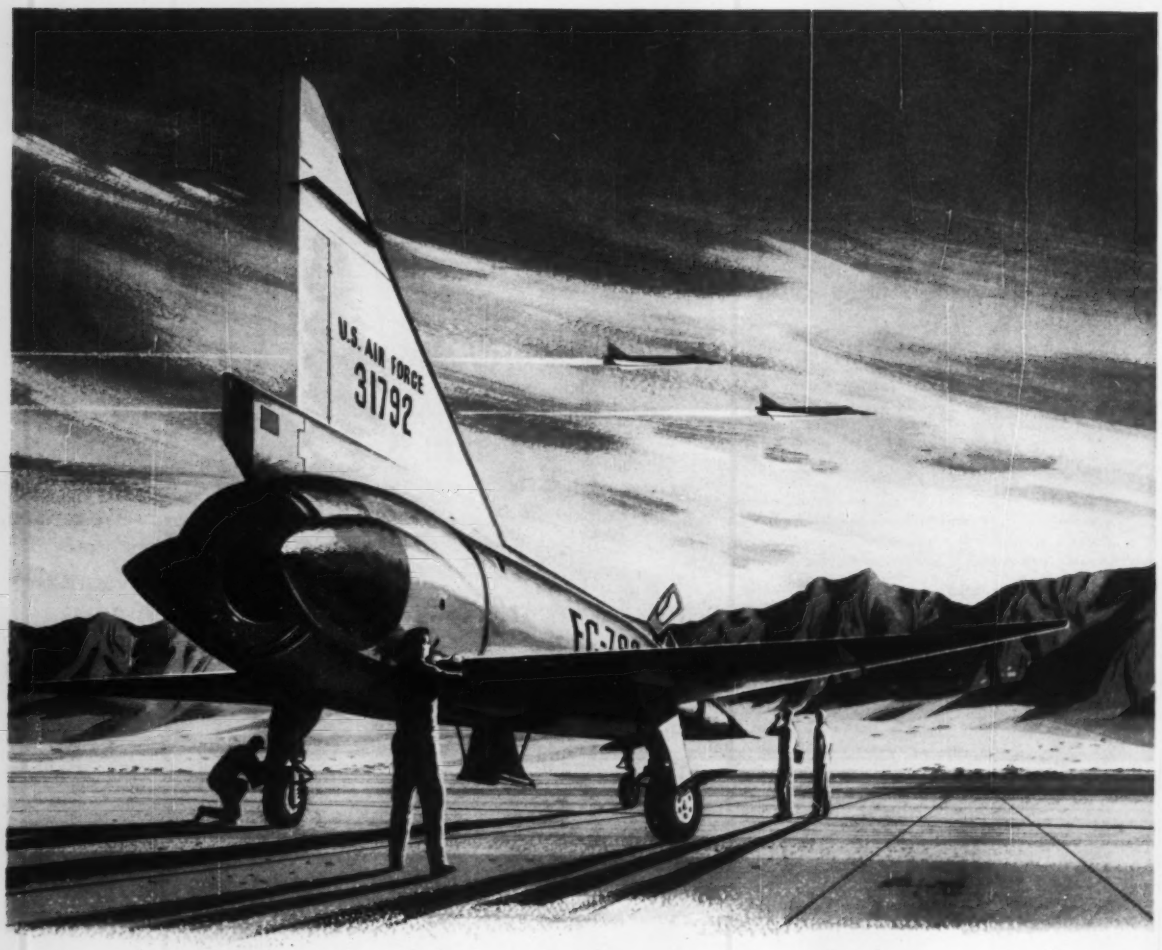
**RETAINING RINGS**

**Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.**
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
*(Please print)*

*Name*.....
*Title*.....
*Company*.....
*Business Address*.....
*City*..... *Zone*.... *State*.....

ME 118

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.




## IDEAL ENGINEERING "CLIMATE"

The many advanced aircraft and missile programs at Convair San Diego today include: *The F-102A Supersonic Interceptor, The Atlas Intercontinental Ballistic Missile, The Metropolitan 440 Airliner, the new Convair 880 Jet-Liner, and a far-reaching study of Nuclear Aircraft.*

Within these vital, highly-diversified Convair projects in beautiful San Diego, California, engineers find the perfect "climate" for a challenging and rewarding engineering career. You will find Convair salaries, computor and test facilities, engineering policies, educational opportunities and personal working advantages the most desirable in the industry.

What's more, you and your family will almost certainly enjoy a new, exciting, happier way of life here . . . where the weather year 'round is unsurpassed.

For a significant engineering career in the engineering "climate" *you* seek, we invite you to forward a full resume today. Write H. T. Brooks, Engineering Personnel, Dept. 623.

Generous travel and moving allowances to engineers.

**CONVAIR**

C-V GD

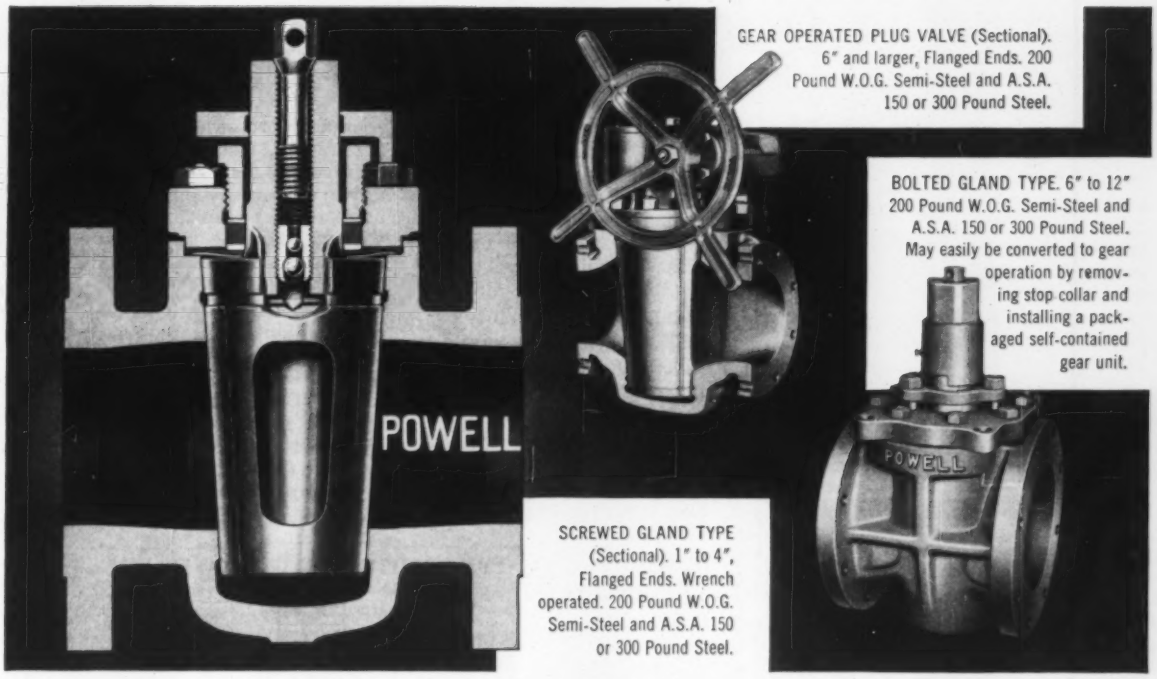
A DIVISION OF GENERAL DYNAMICS CORPORATION

3302 PACIFIC HIGHWAY SAN DIEGO, CALIFORNIA

# POWELL

## *Lubricated Plug*

# VALVES




GEAR OPERATED PLUG VALVE (Sectional). 6" and larger, Flanged Ends. 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel.

BOLTED GLAND TYPE. 6" to 12" 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel. May easily be converted to gear operation by removing stop collar and installing a packaged self-contained gear unit.

SCREWED GLAND TYPE (Sectional). 1" to 4", Flanged Ends. Wrench operated. 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel.

Powell Lubricated Plug Valves maintain our 110-year tradition of quality and precision. Only the finest available materials are used. And painstaking quality control is rigidly enforced through each and every step of manufacture.

Features include quick and positive operation—just a quarter-turn to open or close. Lubricant grooves surrounding each port provide a positive seal when the valve is closed. In an open position, seating surfaces are not exposed.

*Valve users who want one source of supply for lubricated plug as well as all types of bronze, iron, steel and corrosion-resistant valves will want full details on Powell Lubricated Plug Valves.*

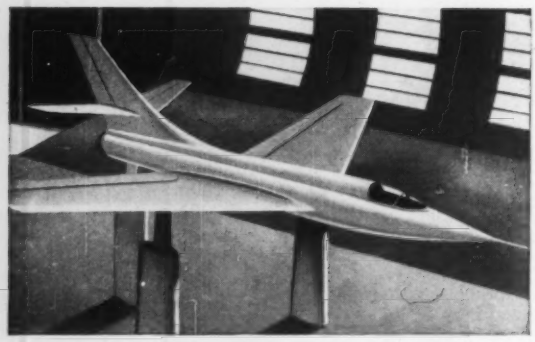
Available in Steel and Semi-Steel through distributors in principal cities. If none is located near you—or if you need help on valve problems—write direct to

PERFORMANCE
PV
VERIFIED

BRONZE, IRON, STEEL AND CORROSION-RESISTANT VALVES

**The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR**

The source of supply for all valve needs!



*To plan tomorrow's aircraft...*

# Brush System records performance in new supersonic wind tunnel

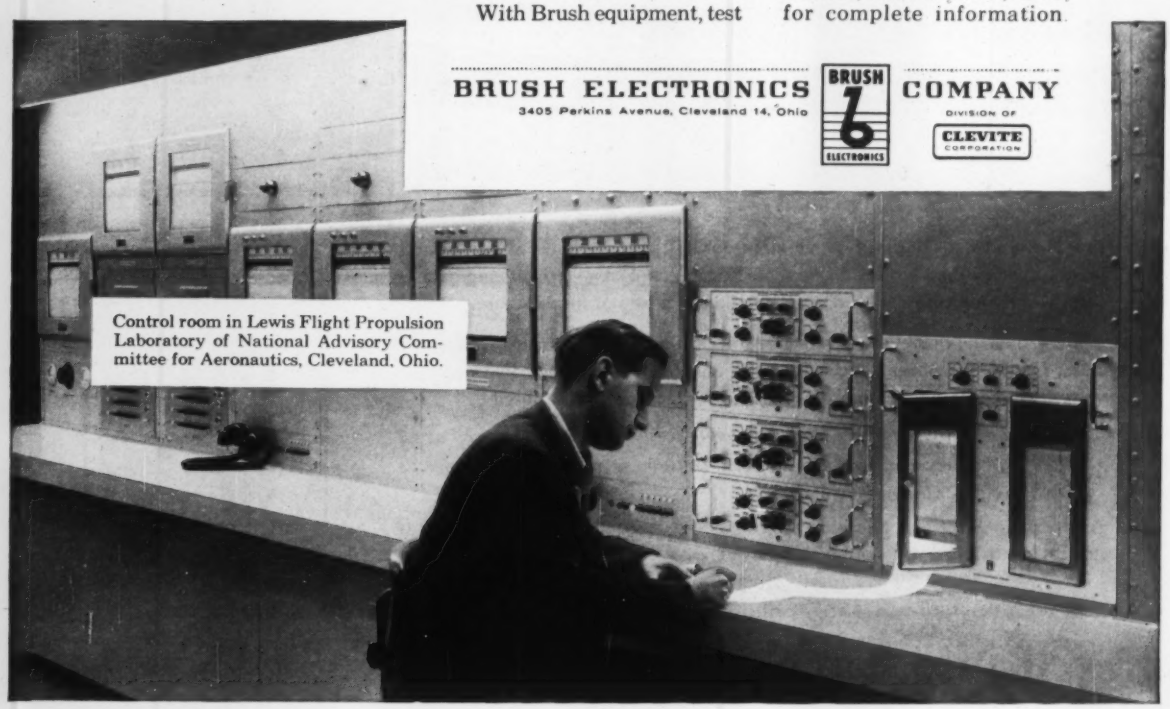
ENGINEERS at N. A. C. A.'s Lewis Flight Propulsion Laboratory use Brush Recording Systems to get the facts on model performance in their new supersonic wind tunnel. This work will help determine the shape of future aircraft.

This N. A. C. A. facility has a 10′ x 10′ test area with air velocities above Mach-2. The instrumentation measures transient pressures at various points, as well as fluctuating aerodynamic forces.

With Brush equipment, test results are recorded clearly, accurately, instantaneously. Brush offers the most flexible direct writing systems available—a choice of ink and electric writing in the same units . . . chart speed range from 10″ per day to 10″ per second.

For virtually any type of measurement, you can obtain the facts quicker and easier with Brush equipment. Consult your Brush representative, or write Brush Electronics Co., Dept. P-11, 3405 Perkins Avenue, Cleveland 14, Ohio, for complete information.

**BRUSH ELECTRONICS COMPANY**
3405 Perkins Avenue, Cleveland 14, Ohio
BRUSH ELECTRONICS — DIVISION OF CLEVITE CORPORATION



Control room in Lewis Flight Propulsion Laboratory of National Advisory Committee for Aeronautics, Cleveland, Ohio.

Welsbach High Pressure Service Gas Valve with Revere Arsenical Bronze Stem.

# REVERE

## Deep-Drilling Brass Rod

### Increases Tool Life over 200% for Welsbach

### Why not try it yourself?

In the manufacture of valves the Kitson Division of The Welsbach Corporation, Philadelphia, Pa., has to deep-drill brass rod. Originally the rod was free-machining brass. However, when Revere discovered the extent of the drilling it was suggested that our Mixture 252, Deep-Drilling Brass, would be preferable. This was tried, and the machine shop foreman reported that tool life was increased over 200%. In one item it is possible to bore with a single operation, against the former practice of withdrawing the drill three times in order to clear the chips. Revere's Deep-Drilling brass produces very small, easily cleared chips.

Another item is a high pressure gas valve, with a cast body and brass rod stem. The rod was changed to arsenical bronze, which costs a bit more, but it ended flaking and galling between stem and seat, and materially reduced rejects. Still another instance of Revere service concerns a hot water heater relief valve. The original model was cut out of bar stock. We suggested a high leaded brass tube, hexagon outside, round inside. This greatly reduces machining, has a better surface, and a better seat. Costs more by the pound, but saves more by the piece.

Revere salesmen and Technical Advisors are always glad to collaborate in seeking ways to save money and improve products. Perhaps we can help you!

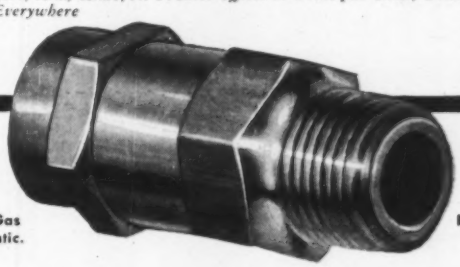
**REVERE**

**COPPER AND BRASS INCORPORATED**

*Founded by Paul Revere in 1801*

230 Park Avenue, New York 17, N. Y.

*Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere*



Welsbach Temperature-Pressure Relief Valve.

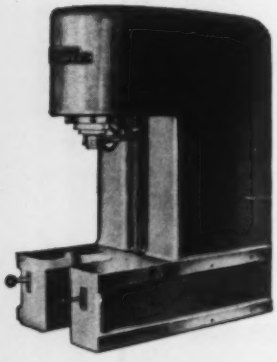
Welsbach Emergency Gas Shut-Off Valve, automatic.

Pressure Relief Valve for water heaters.

How the **HYDRAULIC MULTIPRESS®** works for Whirlpool-Seeger

# *MULTIPRESS®*

## assembles automatic washer parts daily...by the thousands



*8-ton Denison hydraulic Multipress*

All automatic washers, made at the rate of several thousand per day by Whirlpool-Seeger Corporation, require a stamped steel brake disc.

Rivets assemble the stamped discs to flanged hubs die cast in zinc alloy. The two parts are positioned together, rivets passed through small holes in the bottom of the stamping, projecting inside the dished portion of the disc. The four rivets are then upset, fastening the brake disc permanently to the hub.

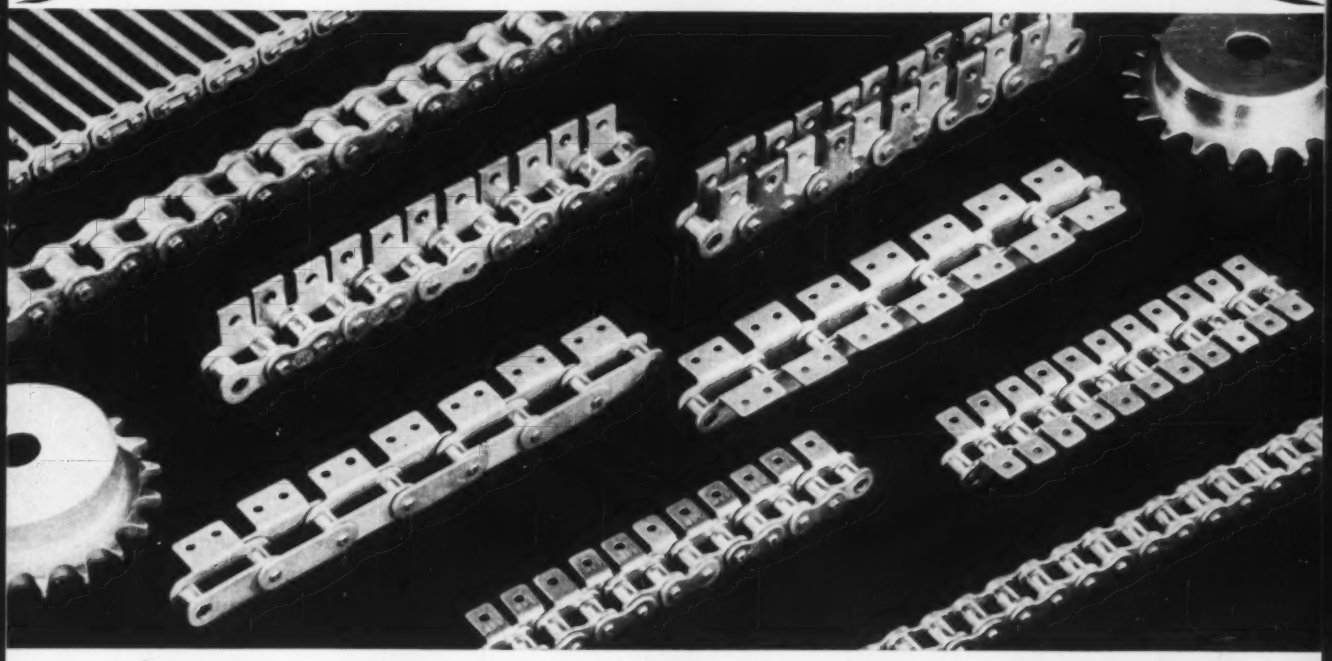
With the 8-ton Denison hydraulic Multipress, the riveting operations are performed with perfect uniformity. Smooth, controlled hydraulic action of the ram avoids a sharp blow, yet applies the proper pressure to the rivets.

Your Denison representative can show you how to improve your manufacturing operations, increase quality, cut production costs. Write Denison Engineering Division, American Brake Shoe Co., 1174 Dublin Road, Columbus 16, Ohio.

**HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS**

**DENISON** Hydr**OIL**ics

# it's NEW! it's Revolutionary it's Electrolized!



# ATLAS ROLLER CHAIN

## CORROSIVE RESISTANT...COSTS 40% LESS
## COMPARATIVE TESTS PROVE IT WEARS 100% LONGER

From coast to coast manufacturers, engineers and transmission drive specialists are acclaiming this as the most revolutionary development in the roller chain field. It meets the most exacting requirements of the chemical, food, beverage and other industries where corrosion resistance is a factor. Yet it has been tested and proved to outlast, outrun and outwear other chains even though it costs far less.

**HIGHER TENSILE STRENGTH**—has same tensile strength as alloy steel chain . . . much higher than bronze or stainless steel chain.

**LONGER WEARING**—actual wear-drive tests prove it lasts as much as 100% longer than alloy steel chain.

**STAINPROOF, CORROSIVE RESISTANT**—corrosion resistance is greatly increased in Electrolized Chain and compares favorably with any other corrosion resistant chain now on the market.

**LOWER PRICE**—of Atlas Chain makes it as much as 40% less in cost than any other corrosion resistant chain now on the market.

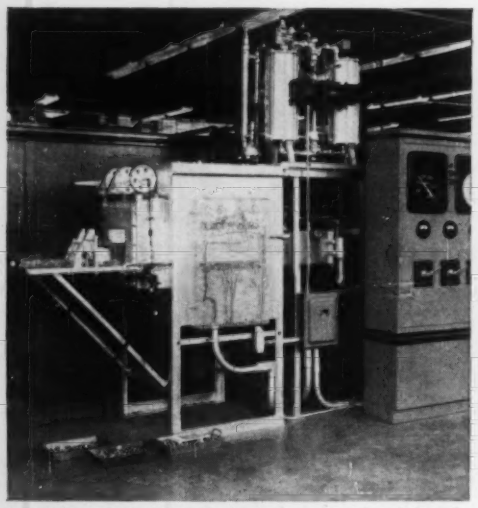
Here's the chain that makes it possible for you to re-evaluate the specifications of your transmission drives. From the standpoint of cost, efficiency and longer wear it allows you to specify corrosion resistant chain on drives previously ruled out due to high cost and short chain life.

You owe it to your plant to contact your nearest Atlas distributor to get the complete story on Atlas Electrolized Roller Chain and Sprockets. He can help you attain a new standard of efficiency on your transmission drives.

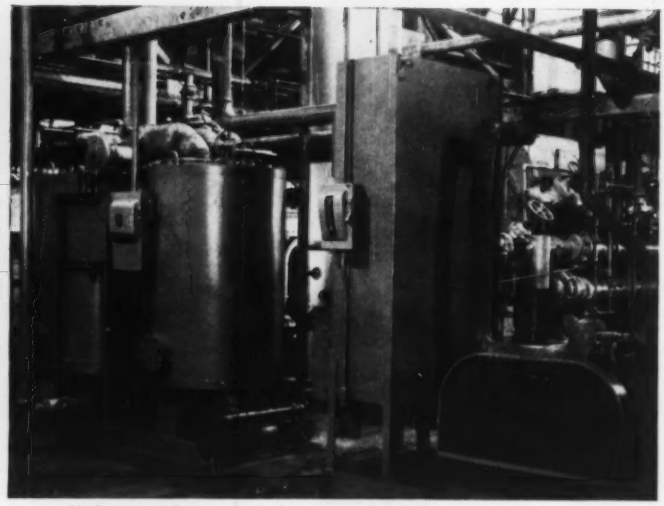
**ATLAS CHAIN AND MANUFACTURING CO.**
**West Pittston, Penna.**

**GET THIS DATA ON ELECTROLIZED CHAIN**

**This free brochure tells you in brief question and answer form all about Electrolized Chain. Write for your copy today.**

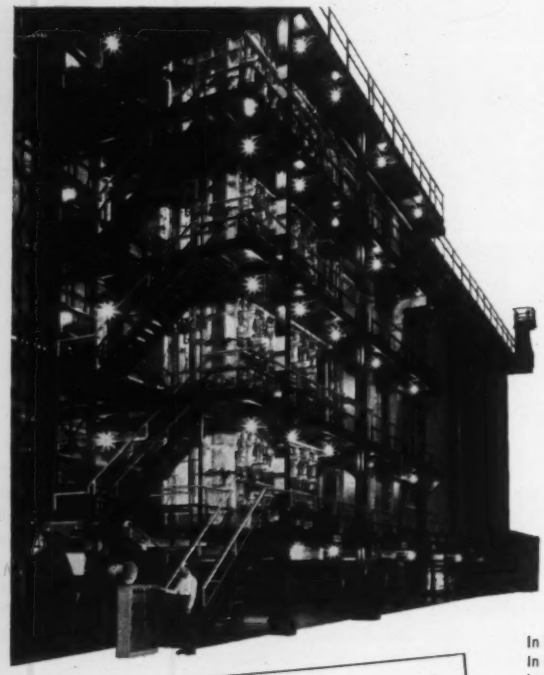


*Bottled gas for this little furnace is dried by the Lectrodryer mounted above it.*



*Controlled atmosphere gas fed from a central generator to all parts of this plant is dried to –40°F. dewpoint by this Type BWC Lectrodryer.*

## When the controlled atmosphere must be DRY your generator builder will likely recommend a Lectrodryer*



YOUR FURNACE and gas generator manufacturer will advise you on heat treating, brazing and sintering methods and equipment. Where the operation is critical and a DRY atmosphere is indicated, he will likely include a Lectrodryer. It provides dependable DRYing and needs very little attention to keep it working year after year.

Consult your regular supplier for help on such problems. Pittsburgh Lectrodryer Co., 335 32nd St., Pittsburgh 30, Pennsylvania (a McGraw Electric Company Division.)

◀ *Five Lectrodryers DRY the 12,000 cubic feet of inert gas that surrounds the 30 tons of tin plate per hour being annealed in this tower-type furnace.*

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S.A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

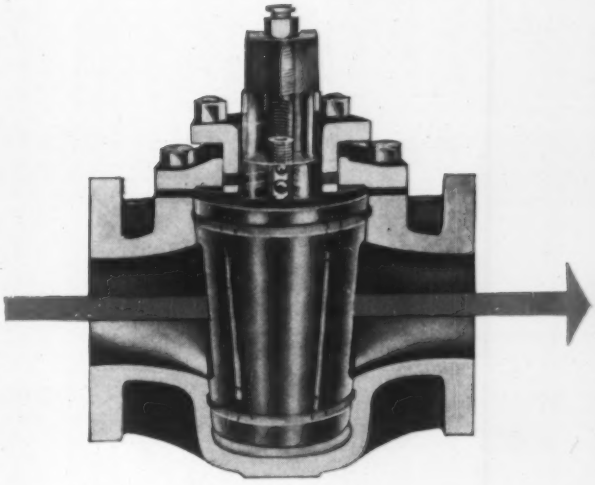
**LECTRODRYER**

* REGISTERED TRADEMARK U S. PAT. OFF.

## Straightway

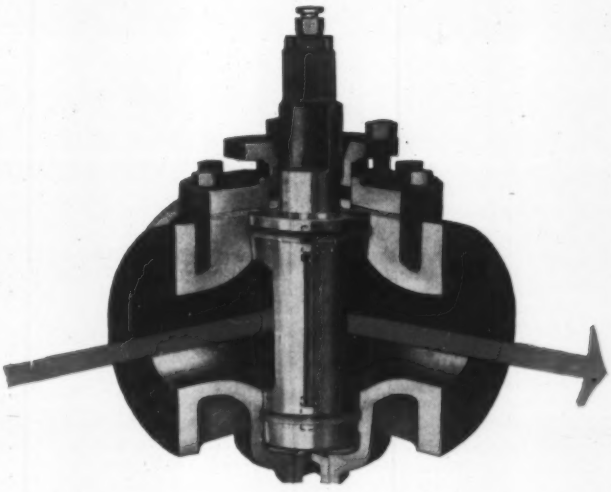
Leakproof Rockwell-Nordstrom Straightway valves cost you no more to buy and far less to use than any other valve. The exclusive Sealdport* lubrication system saves you important dollars in maintenance by eliminating the metal-to-metal friction that wears out other valves so quickly. Expensive seating problems are eliminated on even the toughest service because the Rockwell-Nordstrom valve seats are never *exposed* to the line fluid. Available in a complete range of sizes and pressure ratings in steel, semi-steel, stainless and other corrosion resisting metals.

*Registered trade mark, Rockwell Manufacturing Co.



# *Two ways to*
# Cut Your Valve Costs

**ROCKWELL-**Nordstrom Straightway and Multiport **VALVES**



## Multiport

For such services as tank switching, relief, and blending, Rockwell-Nordstrom Multiport valves stop or change flow on three or four lines. You not only get perfect flow control but you save the cost of three or four ordinary valves . . . piping arrangements are simpler and less costly, too. Lubrication and unexposed seating assure lowest maintenance—longest service, just as in the Straightway pattern above. Rockwell-Nordstrom Multiport valves are available in semi-steel, steel, stainless and corrosion resisting metal in a wide range of pressure ratings and sizes to 16″. Rockwell Manufacturing Company, Pittsburgh 8, Pa. *Canadian Valve Licensee:* Peacock Brothers Limited.

***SEND COUPON FOR MORE DETAILS***

**ROCKWELL-**
Nordstrom
**VALVES**

**Lubricant Sealed for Positive Shut-Off**
**40th YEAR** *of lubricated plug valve leadership*

**ROCKWELL MANUFACTURING COMPANY**
**Pittsburgh 8, Pennsylvania**

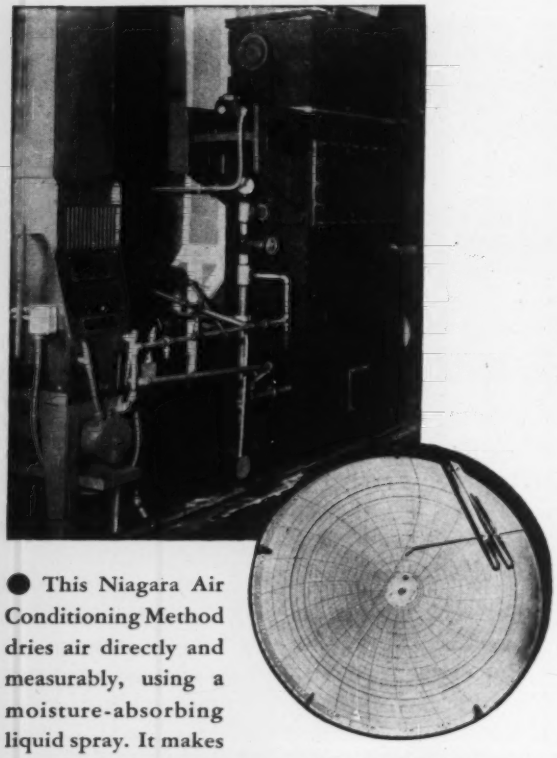
☐ Please send me Bulletin V-215.
☐ Please send me name of nearest Rockwell-Nordstrom industrial distributor.

Name _____ Title _____
Company _____
Street _____
City _____ Zone _____ State _____

# EXACT CONTROL

## of Moisture Content

### To Improve Your Product or Protect Your Materials or for Processes or Tests



● This Niagara Air Conditioning Method dries air directly and measurably, using a moisture-absorbing liquid spray. It makes humidity control a separate function from lowering or raising temperatures and gives you precise control with thermostats alone; no moisture-sensitive devices are needed. You have simpler, more trustworthy, less expensive control instrumentation. Niagara precise-control installations have the best record for reliability.

Niagara Air Conditioning provides you with any temperature and relative humidity you need. Using "Hygrol" absorbent, it is not expensive to operate, saving the refrigeration commonly used to condense moisture and making re-heat unnecessary in most cases. It gives large capacity with compact, easily-maintained equipment. Ask for Descriptive Bulletins #112 and #121. Address Dept. M.E.

**NIAGARA BLOWER COMPANY**

405 Lexington Ave. New York 17, N. Y.

*District Engineers in Principal Cities of U. S. and Canada*

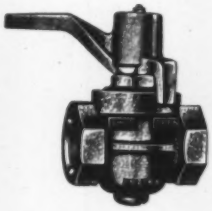
---

# *the DeZurik Difference is in the Plug!*

**RESILIENT-FACED**

Facings of resilient synthetic compounds on the metal-cored plug of a DeZurik Valve provide a cushioned closure which seals dead tight around particles in the flow.

**ECCENTRIC-SHAPED**



The matching eccentric surfaces of the plug and seat wedge tightly shut. In opening the valve, the first fractional movement of the operating lever lifts the plug from the seat; an easy quarter-turn of the lever opens the valve fully. For more details, write

**DeZURIK SHOWER CO.**

SARTELL, MINNESOTA

---

# LENAPE STUDDING OUTLETS *offer many advantages*

Curved Studding Outlets or Pads in ASA sizes and standards provide reinforcement of the shell opening. Studding outlets, naturally short in height and providing reinforcement of the opening, have design appeal, economy in price and fabrication, and advantages in use.

Important applications include interdeck access openings on small diameter towers or columns, boiler mountings, clean-out or observation ports, and similar uses in close-clearance locations.

Sizes 16" and larger (even to 30" I.D.) are ideal access openings and in 18" and 20" sizes are the most modern and economical manway for LPG tanks.

**Complete standards on pages 36-39 of Lenape Catalog 10-53.**

LENAPE HYDRAULIC PRESSING AND FORGING CO.

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 114 WEST CHESTER, PA.
RED MAN PRODUCTS

Hagan Ring Balance Meter integrates data used to compute charges for air conditioning of Gateway Plaza Restaurant at Gateway Center, Pittsburgh

# HERE IS A FLOW METER THAT CAN COMPUTE COSTS

Yes, and then some. The Hagan Ring Balance Meter can do the work of a meter, recorder, computer and controller—simultaneously! Basically, it's a simple mechanical device that measures the flow of any gas or liquid, but its applications in industry are almost limitless.

- *For a central air-conditioning plant*, it measures the exact amount of cooling supplied to each customer, at the same time computes how much each is to be billed.
- *For utilities and their customers*, the Hagan Ring Balance Meter measures the volume of flowing gases or steam or water. It makes accounting easier for both supplier and user, because it measures and records accurately. Its records can be used directly for billing.
- *In a large chemical plant*, it measures varying amounts of both water and alcohol in a flowing, mixed solution, and records the quantity of pure alcohol.

The Hagan Ring Balance Meter is so versatile that it can record up to four measurements simultaneously; measure specific gravity or density; automatically correct for temperature or pressure changes; integrate multiple flow data; and activate controls automatically.

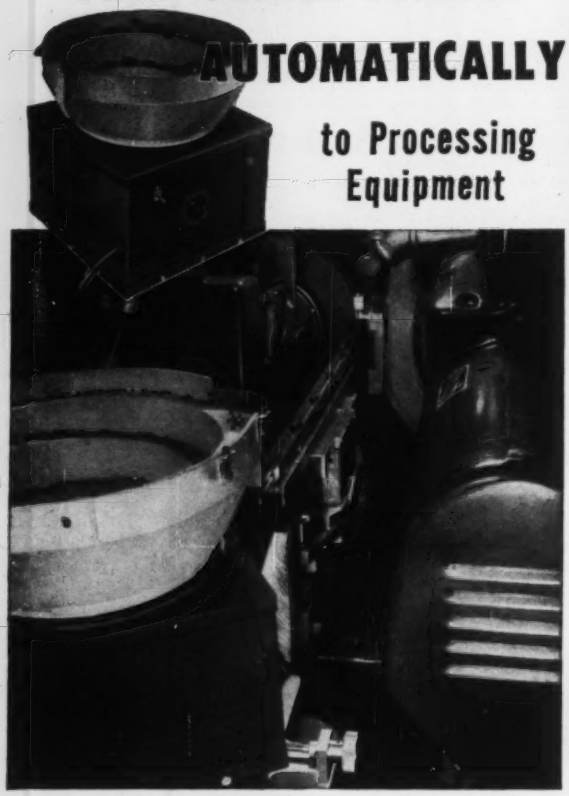
This rugged yet sensitive instrument is typical of the advanced aids to industry which Hagan provides . . . in such varied fields as combustion and process control, force measurement, and industrial water conditioning.

Write for detailed information on Hagan Ring Balance Meters, included in our brochure of products and services. Ask for Bulletin GSP-901.

HAGAN

HAGAN CORPORATION
CHEMICALS AND CONTROLS
Hagan Building, Pittsburgh 30, Pennsylvania
Subsidiaries: Calgon, Inc. • Hall Laboratories, Inc.

# FEED SMALL PARTS AUTOMATICALLY to Processing Equipment



with *SYNTRON*

# PARTS FEEDERS

Now Syntron not only offers you an automatic controlled method of handling, positioning and feeding small parts, but they can provide, within reasonable limits, gravity feed tracks that will deposit the part in placing devices, indexing tables, dies, cavities, etc. Electromagnetic vibration can do the work of many hands—write for free illustrated bulletin.

*Other SYNTRON Equipment of Proven, Dependable Quality*

**HEATING ELEMENTS**

Cut production time and costs on baking, heating and drying processes. Flat, uniform radiation.

**SHAFT SEALS**

Self-contained seals that eliminate leaking shafts do away with repacking expenses.

**INFRARED HEATING PANELS**

They heat by direct radiation not by reflection. Radiate even heat pattern with no blind spots.

**SYNTRON COMPANY**
498 Lexington Avenue — Homer City, Pa.

# "MONOBALL"®

Self-Aligning Bearings

CHARACTERISTICS

| | ANALYSIS | RECOMMENDED USE |
|---|---|---|
| 1 | Stainless Steel Ball and Race | For types operating under high temperature (800-1200 degrees F.). |
| 2 | Chrome Moly Steel Ball and Race | For types operating under high radial ultimate loads (3000-893,000 lbs.). |
| 3 | Bronze Race and Chrome Moly Steel Ball | For types operating under normal loads with minimum friction requirements. |

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. Dept. ME-56

**SOUTHWEST PRODUCTS CO.**
1705 So. Mountain Ave. • Duarte, California
(LOS ANGELES COUNTY)

# 1-2 & 3 element SPEED SENSITIVE SWITCHES

1. Overspeed and Underspeed Governors are built to open or close a set of contacts when operating speed increases to dangerous proportions or when the speed drops to below normal running. Overspeed governors can be supplied to trip at any speed between 500 and 10,000 R.P.M. Underspeed governors at any speed between 400 and 5,000 R.P.M.

2. Constructed to open or close two independent sets of contacts at adjustable speeds. Both switches trip on increasing speed and reset automatically on decreasing speed. Can also be furnished with a manual reset button, in which case it is necessary to reset the high speed switch after it has tripped.

3. Designed to open or close three independent sets of contacts at three different speeds. Particularly adaptable to the more elaborate engine and turbine control systems. Model shown is arranged for direct mounting on an AND 20005 engine tachometer pad.

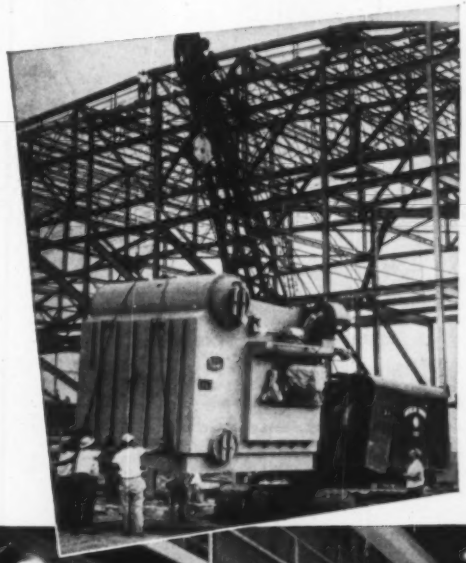
*These units are incased in dust and splash-proof housings.*

**SYNCHRO-START PRODUCTS**
INCORPORATED
8151 N. RIDGEWAY AVE., SKOKIE, ILL.

# Look for this honored Name Plate . . .

Vogt

## a guide to advanced designs in package unit and custom built steam generating equipment



Vogt steam generating units are available in types and sizes to meet individual plant needs for power, processing or heating.

Package units range from 10,000 to 40,000 pounds of steam per hour while custom built units are obtainable in the larger capacities. Available in bent tube types and straight tube, forged steel sectional header types for solid, liquid or gaseous fuels burned singly or in combination.

*Write for Bulletins, Dept. 24A-BM*

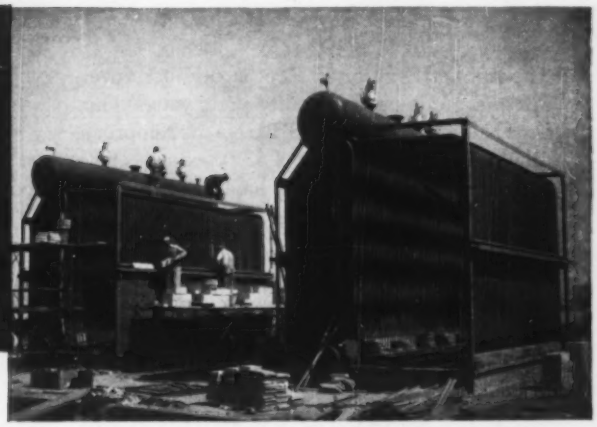
**HENRY VOGT MACHINE CO.**
Box 1918, Louisville 1, Kentucky

**SALES OFFICES**
New York, Chicago, Cleveland, Dallas, Philadelphia
St. Louis, Charleston, W. Va., Cincinnati, San Francisco

One of three 15,000 #/hr. capacity package unit steam generators for a State institution.

Two of three 41,000 #/hr. steam generators installed in Medical Center Steam Plant, Louisville, Ky.

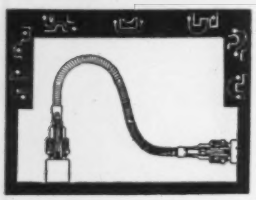
Erecting two 50,000 #/hr. steam generators at Kelly Air Force Base, San Antonio, Texas.



**OTHER VOGT PRODUCTS**

Drop Forged Steel Valves, Fittings and Flanges in a complete range of sizes • Petroleum Refinery and Chemical Plant Equipment • Steam Generators • Heat Exchangers • Ice Making & Refrigerating Equipment

## SIMPLIFIED TRANSMISSION OF POWER



It was only a few years ago that transmitting power around a corner or over an obstacle required the use of universal joints, bevel gears, or gear trains. This gearing was not only very expensive, but it also consumed much needed space, causing a headache for the design engineer, the production department and those who had to service the finished product. Today it is possible to realize the maximum space available through the utilization of flexible shafting which eliminates all gearing efficiently and economically. You may do this because flexible shafting transmits power over, under, and around all obstacles while operating under a very high torque. In the illustration you will notice how much more direct and simpler is the flexible shaft. You will notice too that complicated alignment is unnecessary because of the high flexibility of the flexible shaft assemblies. There are very few moving parts to a flexible shaft assembly which does away with vibration and offers long life.

For complete information on how flexible shafting can be applied to your product or plant, write on your letterhead to the F. W. Stewart Corporation, Dept. ME, 4311-13 Ravenswood Avenue, Chicago 13, Illinois.



# Imperial

*the world's finest*

TRACING CLOTH

In drafting rooms throughout the world Imperial quality is the standard by which fine tracing cloths are judged. This has been true for decades, and Imperial remains the finest tracing cloth because its makers have continued to improve its quality and value.



**Natural . . . Synthetic . . . Silicones**

# RUBBER

**SPECIALIZED PARTS BY EBERHARD FABER**

The Rubber Division of Eberhard Faber develops and produces the quality parts you require from Natural Rubber, GRS, BUNA-N, Neoprene, Silicone. Rubber bonding of all types—specialty items molded, extruded or hand-built to your precise specifications.

Write for blueprint and specification study, field inspection, and cost analysis. Address inquiries to: Dr. E. A. Loy, Rubber Division, Dept. ME-11, Eberhard Faber Co., 47 Colden Street, Newark, New Jersey.

**EBERHARD FABER**

RUBBER FOR INDUSTRY FOR 50 YEARS



MECHANICAL ENGINEERING

October, 1956 CARD INDEX Vol. 78, No. 10

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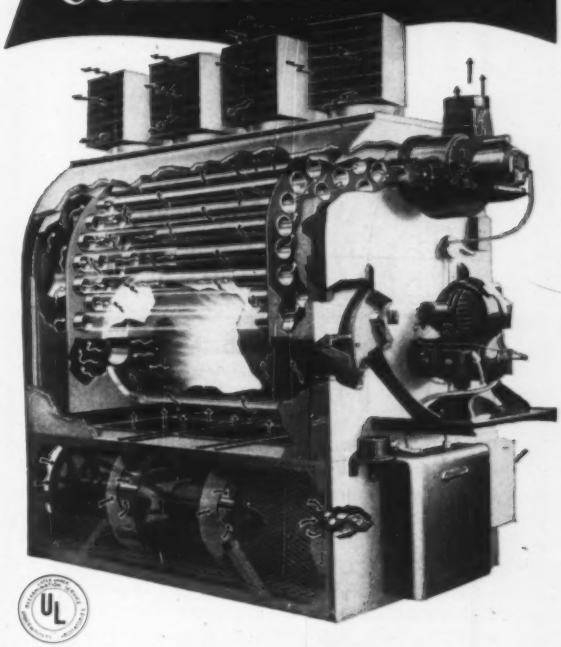

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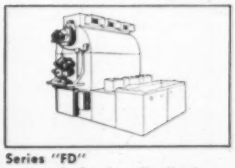

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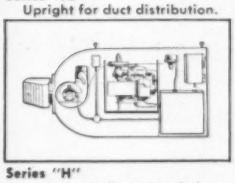

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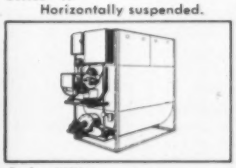

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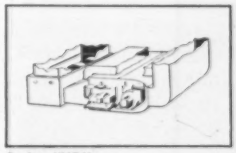

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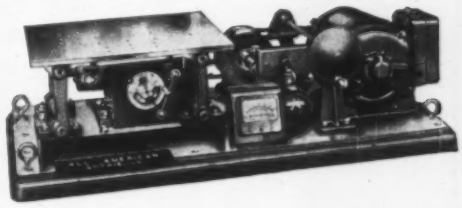

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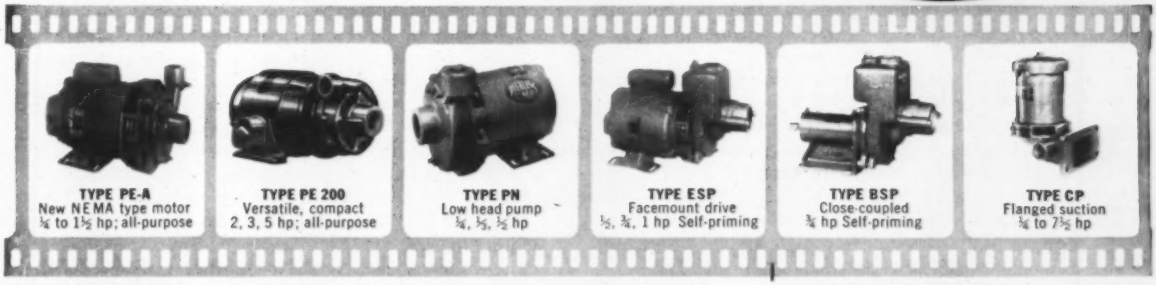

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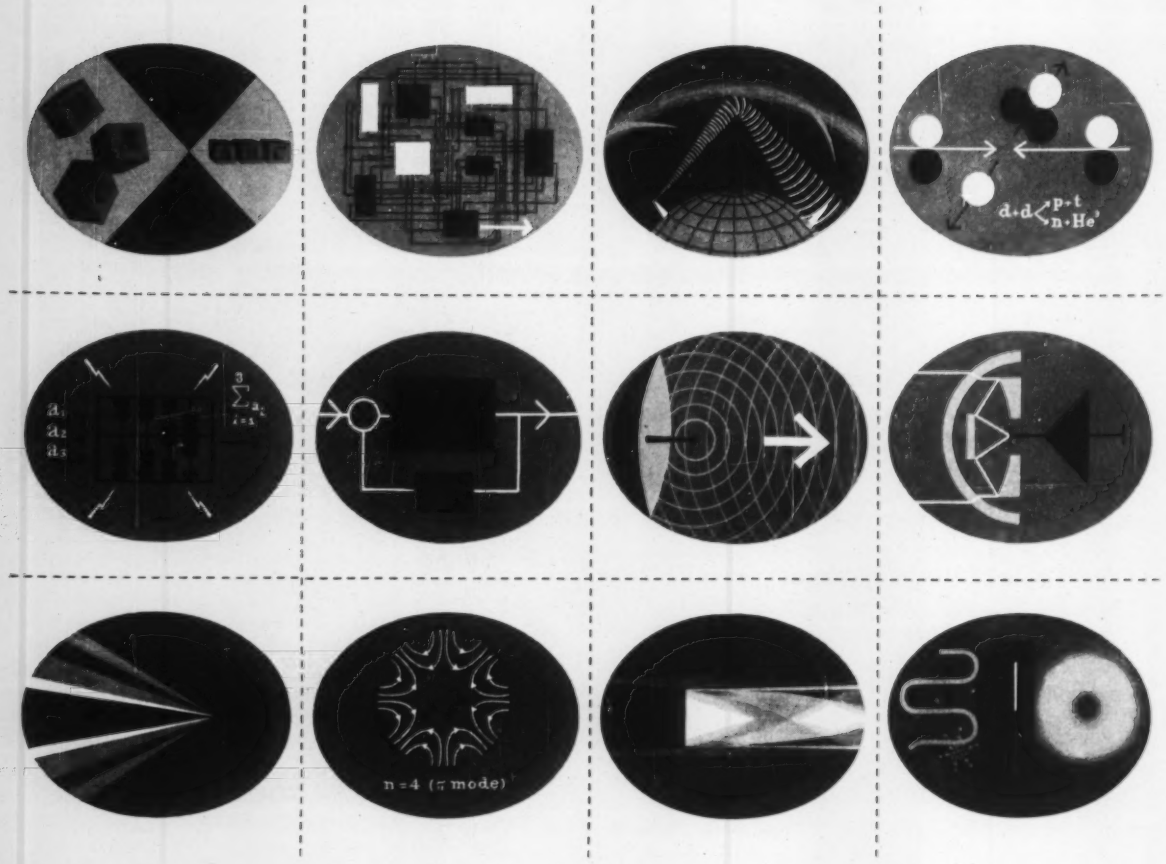


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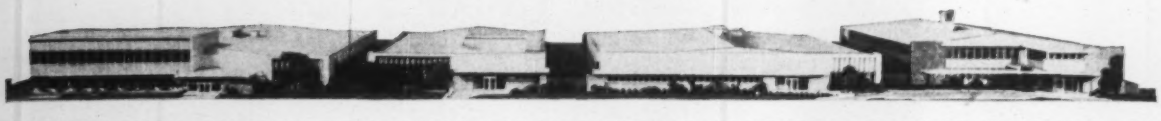

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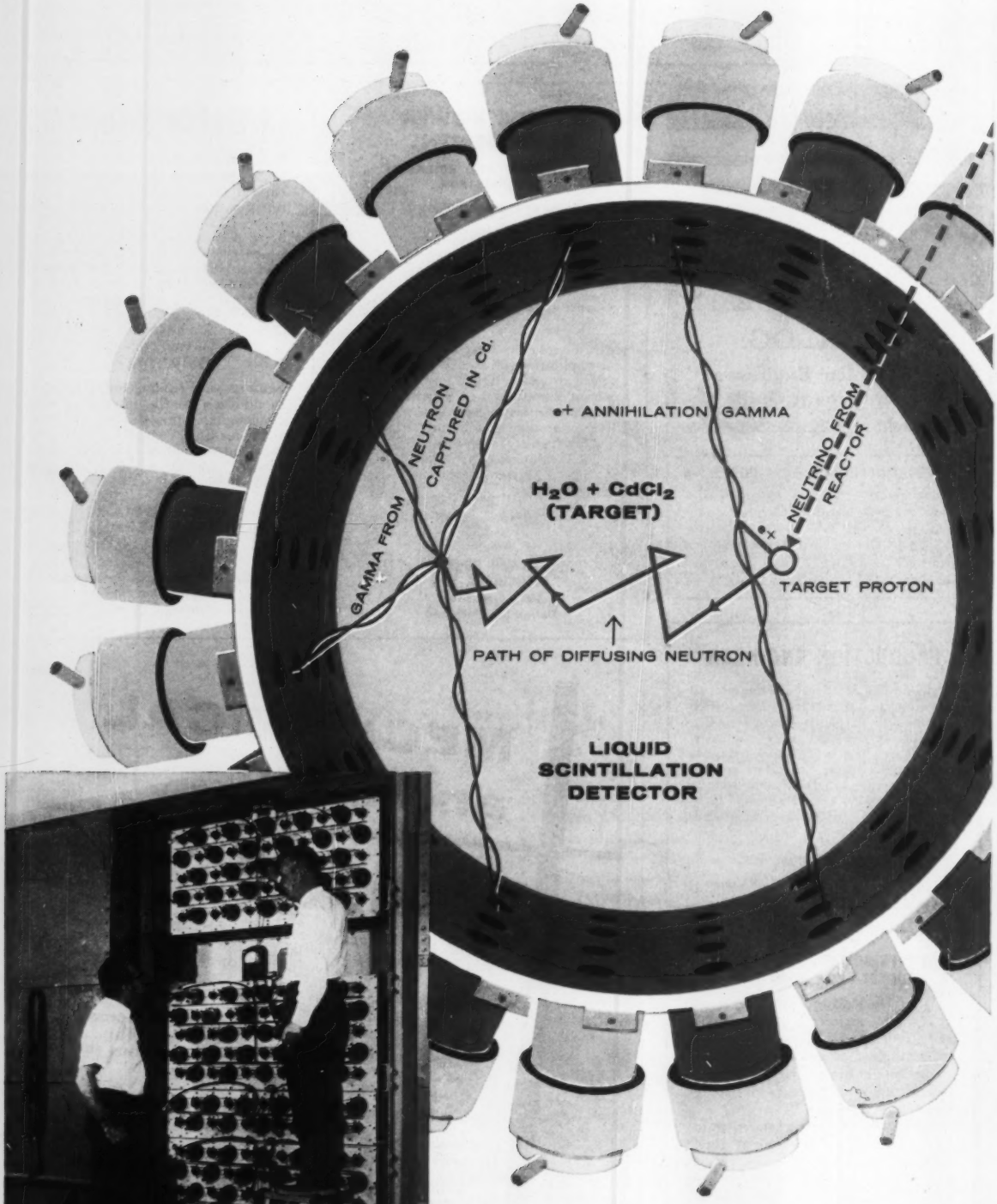


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*C. L. Cowan, Jr., F. Reines, F. B. Harrison, H. W. Kruse, A. D. McGuire, *Science* 124, 103 (1956)

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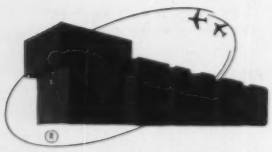

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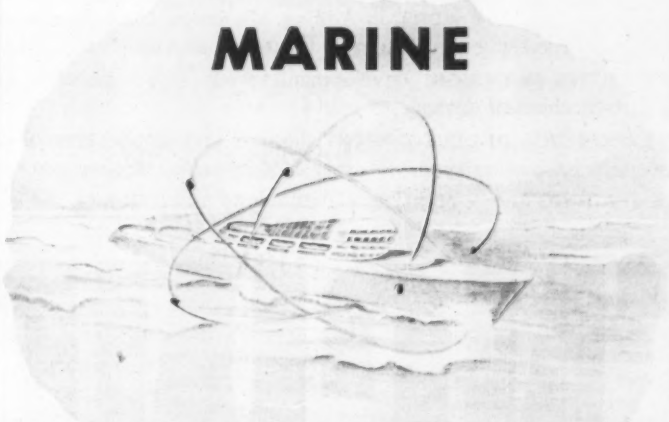

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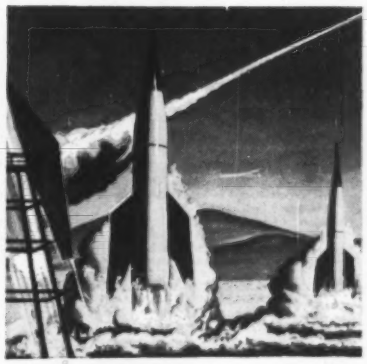

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# DESIGNERS

## ...if YOU are interested in MORE than "just a job"

## DU PONT is interested in YOU!

Please send complete resume, including details of education and experience, to:
**Mr. T. J. Donovan**
**Engineering Department**

DU PONT
REG. U.S. PAT. OFF.

*Better Things for Better Living . . .through Chemistry*

To a designer who seriously wants to grow in his field,
**Du Pont Offers Real Opportunity.**

Work on interesting, challenging, professional assignments. Du Pont's vast research program assures diversification. Your assignments will include work in synthetic fibres, heavy chemicals, pigments, finishes, plastics, photo products, electrochemicals and many other fields.

Progress and promotion are commensurate with ability and performance.

Comprehensive and varied training programs to develop both technical and administrative abilities.

Promotion-from-within. This, plus continuous Company growth, assures both excellent advancement opportunities and stability.

Progressive benefit programs provide immediate and long-term security — majority company-paid.

**APPLY NOW** to fill one of these immediate openings for:

**PROCESS DESIGNERS**
**PROCESS EQUIPMENT DESIGNERS**
**HEATING & VENTILATING DESIGNERS**
**MECHANICAL DESIGNERS**
**MACHINE DESIGNERS**
**INSTRUMENT DESIGNERS**
**POWER DESIGNERS**

## E. I. du Pont de Nemours & Co., Inc.

**Wilmington 98, Delaware**

*Engineer, ME EE or AE*

**Controls Design**

**Nuclear Aircraft Engines**

First came the propeller, followed by the jet engine—and now, aircraft nuclear propulsion with its tremendous power potential. General Electric's ANP Department has a career opening for the qualified engineer who desires to achieve the professional stature his talents deserve.

The present position requires 1 to 3 years' experience in aircraft control or accessory systems design and application, and involves the design of turbine type engine controls. Both creative and analytical ability are desirable.

Openings in Cincinnati, Ohio
and Idaho Falls, Idaho

Address replies, stating salary requirements, to location you prefer

J. R. Rosselot
P. O. Box 132
Cincinnati, Ohio

L. A. Munther
P. O. Box 535
Idaho Falls, Idaho

GENERAL ELECTRIC

## RESEARCH ENGINEER

Conduct fundamental structural research on paper and paperboard containers. The duties of the position involve setting up and carrying out research projects in co-operation with other members of the department. Develop or devise appropriate theory where possible and devise the experimental program for validating the theory. In the absence of theory, carry on exploratory experimental programs to establish the fundamental laws governing the behavior of paper, paperboard, and containers made there-from. Design and calibrate experimental equipment. Operate, or supervise the operation of the experiment. Analyze the data by means of statistical technique where possible, and render a written report which includes conclusions and recommendations for future work. Occasionally must orally present a review of the research projects to a sponsoring group.

Standard equipment normally used in the department includes tension and compression testing machines, electric strain gages, and associated instrumentation,microscopes and paper converting equipment.

REQUIREMENTS

Education: M.S. or Ph.D. degree in Mechanics, Physics, Mechanical Engineering, or Civil Engineering with strong emphasis on mechanical or structural behavior of materials desirable. Courses in advanced strength of materials, theory of plates and shells, and experimental stress analysis highly desirable.

Experience: At least one year in a responsible engineering position in a research laboratory or structural design firm highly desirable.

Address CA-5964, % "Mechanical Engineering."

## GUIDED MISSILE RESEARCH and DEVELOPMENT

**Positions open for men with 0—4 years' experience**

MECHANICAL or CHEMICAL ENGINEER, or PHYSICIST (advanced degree or equivalent experience) to do fundamental research in interior ballistics.

B.S. MECHANICAL ENGINEES with inspection or machine shop experience to supervise Components Inspection Group.

B.S. or M.S. MECHANICAL, CIVIL or ELECTRICAL ENGINEERS to plan and complete mechanical design phases of rocket component research.

CHEMICAL ENGINEERS, PHYSICISTS, MATHEMATICIANS (B.S., M.S., or Ph.D.) for applied ballistics research work.

B.S. or M.S. CHEMICAL ENGINEERS to do design and development work on rocket components.

Write to **EMPLOYMENT OFFICE**

**HERCULES POWDER COMPANY**
**ALLEGANY BALLISTICS LABORATORY**
**Cumberland, Md.**

## PIPING ENGINEERS

Qualified piping engineers and designers, preferably with 5 years experience or more, can broaden their professional responsibilities with C F Braun & Co. The work is on engineering and design of complete integrated petroleum refineries and petrochemical plants, many types of individual process units, and power plants.

Assignments include arrangement of plant equipment and facilities, layout of process and utilities piping, stress analysis of piping systems, design of spring supports, and preparation of specifications for piping materials and insulation.

Top salaries. Fine facilities. Profit-sharing retirement plan. Write to the head of our Personnel Department, Mr F B Stratford.

C F BRAUN & CO
ALHAMBRA CALIFORNIA
*Engineers*
*Consultants Constructors*

## Staff Industrial Engineer

Challenging opportunity in the Staff Industrial Engineering Department of a leading and expanding manufacturer of aircraft, automotive and electronic parts serving fifteen autonomous divisional industrial engineering groups. Staff functional responsiblity is very broad and offers exceptional opportunity for self expression, experience and development in the most advanced techniques.

Applicant should be a graduate engineer with 8-10 years' diversified industrial engineering experience in metal manufacturing, including supervision, budget and inventory control and a thorough knowledge of time study and methods. Infrequent travel.

Submit detailed resume, including present earnings and availability for interview to: Technical Employment

**THOMPSON PRODUCTS, INC.**
23555 Euclid Avenue — Cleveland 17, Ohio

## ENGINEERING WITH ... *Linde*

- EQUIPMENT DESIGN
- FABRICATING TECHNIQUES
- INSTRUMENTATION AND CONTROLS
- THERMODYNAMICS AND HEAT TRANSFER
- PILOT PLANT DESIGN AND OPERATION
- PROCESS ENGINEERING
- STRESS ANALYSIS

We have excellent openings for Mechanical Engineers in projects associated with the production and distribution of oxygen, nitrogen and argon as low temperature liquids or gases.
LOCATION: Our Tonawanda Laboratories in suburban Buffalo, New York—LINDE'S largest research and development facilities.
B.S., M.S., Ph.D. graduates—send resume covering education (approximate academic achievement), experience and work interests to:

**LINDE AIR PRODUCTS COMPANY**
a division of
**UNION CARBIDE AND CARBON CORPORATION**
P. O. Box 44, Tonawanda, New York
Attention: Mr. R. P. Kalle
Refer to ad: ME-L

## SALES ENGINEERS WANTED

Excellent opportunities for engineers with well established East Coast Industrial Manufacturer now expanding branch office coverage.

Electrical, Mechanical, or Electronic Engineers preferred.

Openings in Oregon, San Francisco, St. Louis, and Detroit.

Generous company paid benefits include hospitalization, pension, insurance, and vacation plans.

Address CA-5940, % "Mechanical Engineering."

## MECHANICAL ENGINEER

Graduate mechanical engineer in power plant design work. Experience not required. Excellent opportunity with consulting engineering firm in the Middle West. Liberal benefit plans and good working conditions.

Send resume of education and experience with statement of salary requirements.

Address CA-5905, % "Mechanical Engineering."

## GRADUATE MECHANICAL ENGINEER

Mechanical Engineer with College Degree and five years' experience desired by Midwest public utility in high pressure power plant operation. Good working conditions and employee benefits.

Write stating education, experience, salary expected, and availability. All replies will be held confidential.

Address CA-5954, % "Mechanical Engineering."

## MAINTENANCE ENGINEERS

**Plant Equipment Inspectors**

**Openings for graduate Metallurgical, Chemical, Mechanical and Industrial Engineers in new Chemical Maintenance Engineering Section of Pittsburgh Coke & Chemical Company.**

**Graduate engineers in the above mentioned classifications having 0 to 10 years' experience in chemical plants or petroleum refineries write or call:**

Carl D. Thomas, Supervisor
Maintenance Engineering

**PITTSBURGH COKE & CHEMICAL COMPANY**

Neville Island
Pittsburgh 25, Pennsylvania
Spalding 1-4400

# Picture of a young man

# Planning a Successful Future!

Success doesn't just happen to a company or to an individual. Success comes as a result of clear thinking and long-range planning.

And that is just what the young engineer in the picture is doing. He is studying the many possibilities of a career in guided missiles.

The book he is reading is entitled "Your Future in Guided Missiles with Bendix". It is one of the most complete guides to job opportunities in the guided missile field. It also contains a detailed background of the functions of the various engineering groups such as systems analysis, guidance, telemetering, steering intelligence, component evaluation, missile testing, environmental testing, test equipment design, reliability, propulsion and other important engineering operations.

Here is exactly the type of information that every ambitious engineer should have if he is concerned about his future. A copy of this thirty-six-page book is available to you. Just fill in the coupon. It may help you plan your successful future.

***Prime Contractor for TALOS MISSILE***

BENDIX PRODUCTS DIVISION
MISSILE SECTION
409C Bendix Drive, South Bend, Indiana

**Please send me a copy of the book "Your Future in Guided Missiles."**

*Name* _____

*Address* _____

*City* _____

*State* _____

**DESIGNERS**

WHERE do you start training for promotion from your first day on the job?

*For the answer, turn to page 171*

**GOODYEAR ATOMIC CORPORATION**

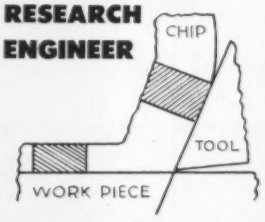
**POSITIONS NOW OPEN IN PLANT ENGINEERING— PRODUCTION—DEVELOPMENT FOR**

**ENGINEERS**
**CHEMISTS**
**TECHNICAL WRITERS**
**METALLURGISTS**
**STATISTICIANS**
**PHYSICISTS**

Positions open on several levels of responsibility. Forward comprehensive resume to:

**EMPLOYMENT DEPARTMENT CC**
**GOODYEAR ATOMIC CORPORATION**
**BOX 628, PORTSMOUTH, OHIO**

**METAL CUTTING RESEARCH ENGINEER**




The man for this position is a Mechanical Engineer, interested in the engineering application of fundamental principles, with aptitude in laboratory work, and ability to plan and carry out original investigation. He should possess a sincere desire to learn and to accept responsibility. A knowledge of elementary machining is very desirable. The position is permanent, and requires responsibility for planning and executing projects in applied metal cutting research. Recognition for individual accomplishments. Many Company benefits.

*Contact M. Eugene Merchant*
*Assistant Director of Research*
**The Cincinnati Milling Machine Co.**
MARBURG AVE., CINCINNATI 9, OHIO

**THE DOW CHEMICAL COMPANY**
**Baton Rouge, Louisiana** **Freeport, Texas**

**CHALLENGING OPPORTUNITIES**

**FOR**

**MECHANICAL ENGINEERS**
**CIVIL ENGINEERS**
**INDUSTRIAL ENGINEERS**

AT FREEPORT, TEXAS—located 60 miles south of Houston on the Gulf Coast. Excellent recreation facilities, fishing, swimming and golf.

AT BATON ROUGE, LOUISIANA—a newly created division located in the capital city of Louisiana and the home of L. S. U. A bustling, growing city in the center of the oil and chemical industries.

**PERMANENT OPENINGS IN**

**POWER — GAS AND WATER — PRODUCTION — PLANT DESIGN**
**PROCESS DESIGN — MAINTENANCE — CONSTRUCTION**

An excellent employee benefit program includes insurance, vacation, hospitalization, pension and profit-sharing, and stock-purchase plans.

**MOVING EXPENSES PAID**

Send résumé of experience, education, age, salary requirement to

**F. P. Hammond**
Industrial Relations Dept.
**The Dow Chemical Company**
**P. O. Box 389**
**Baton Rouge, Louisiana**

**D. M. Duguid**
Technical Employment Dept.
**The Dow Chemical Company**
**Freeport, Texas**

**MECHANICAL ENGINEERS**

Major Oil Company has openings for Mechanical Engineers in several phases of refinery engineering. Locations near New Orleans and south Arkansas. Attractive salary and benefits program. In reply give age, education, experience and salary expected.

**PAN-AM SOUTHERN CORPORATION**

**P.O. Box 2 New Orleans 6, Louisiana**

## HEAT EXCHANGER ENGINEERS

Required for responsible positions in our sales and engineering departments. Engineering degree and five years' experience on tubular heat transfer thermal and mechanical design desirable. Other positions open for engineers with pressure vessel and column experience.

Contact J. R. Piersol, Personnel Manager

**Downingtown Iron Works, Inc.**
**Downingtown, Penna.**

## HEAT TRANSFER ENGINEER

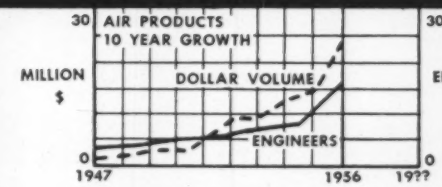
**WANTED FOR POSITION IN NEW YORK CITY**

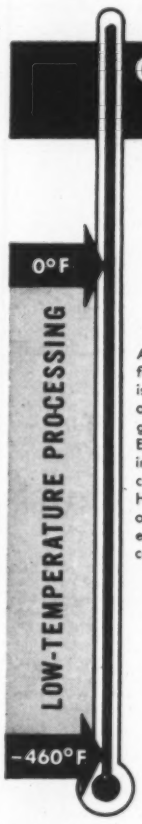
Mechanical or Chemical Engineer with experience in rating/estimating shell and tube heat exchangers.

Send resume and salary requirements to

**Ross Heat Exchanger Div.**
**of American-Standard**
**40 West 40th Street**
**New York 18, N. Y.**

## Chemical & Mechanical Engineers OPPORTUNITY




Air Products offers you the opportunity to advance professionally and financially in the field of low temperature processing. The company is the leader in the engineering, design, manufacture, and construction of oxygen plants and systems for the separation of low boiling point gases such as Oxygen, Nitrogen, Carbon Monoxide, Hydrogen, Methane, Ethane, Ethylene and other basic building blocks of the petrochemical industry. We must expand the entire organization to meet the increasing demands of the steel, metallurgical, and chemical industries. Huge plants are being constructed to meet the liquid oxygen demands of the guided missiles program. We need chemical and mechanical engineers who want to share in the growth and profits of a dynamic company in a new and basic industry.

Openings are available in Process Design, Project Engineering, Estimating and Economic Evaluation, Equipment Design, Sales Engineering, Manufacturing Engineering, Supervision of Oxygen Plant Operations and other areas for which you might be qualified. To arrange confidential interview, send resume to Technical Personnel Manager.

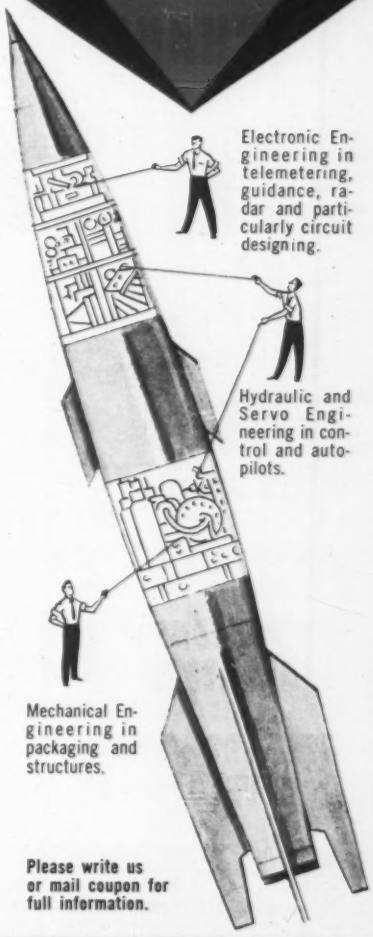
*Air Products*
INCORPORATED
**P. O. Box 538 Allentown, Penna., U.S.A.**

## MECHANICAL ENGINEERS

### Also have a Challenging Opportunity

The mechanical group develop, design, and manufacture expansion turbines and engines, and pumps for operation of extremely low temperature (minus 300°F). Also has responsibility for specification and selection of complex power and compression equipment, including centrifugal, rotary, and reciprocating compressors, and steam, gas turbine; Diesel and gas engine, and electric drives to several thousand unit horsepower. In Air Products, the mechanical equipment is an integral part of the process. Excellent opportunity for broad experience with growth potential. Applicants should be oriented in the actual design of machinery.

## THIS IS THE KIND OF ENGINEERING HELP WE NEED!



Electronic Engineering in telemetering, guidance, radar and particularly circuit designing.

Hydraulic and Servo Engineering in control and autopilots.

Mechanical Engineering in packaging and structures.

**Please write us or mail coupon for full information.**

**W. C. Walker, Engineering Employment Mgr.**
**Pacific Division, Bendix Aviation Corp.**
**11604 Sherman Way, North Hollywood, Calif.**

I am interested in this engineering field____
I am a graduate engineer with____degree.
I am not a graduate engineer but have ____ years experience.

Name_____

Address_____

City_____

Zone____State_____

## MECHANICAL ENGINEER

A large Midwest laboratory offers an excellent opportunity for a person with qualifying experience to work on hydrocarbon gas production processes. Work involves evaluating existing processes and developing improved processes for reforming hydrocarbon feed stocks into gases for chemical manufacture and industrial use. Attractive ideas will be developed by pilot plant operations. Applicants with training and experience in above areas are desired but initiative and ability are of most importance. Send details of experience, education and salary requirements. Replies will be given prompt consideration and will be held in complete confidence.

Address CA-5943, % "Mechanical Engineering."

## SENIOR ENGINEERS PHYSICISTS

**Senior Engineers**—Qualified mechanical or chemical engineers with power or research reactor systems experience.

**Physicists**—Senior and intermediate theoretical reactor physicists for assignment in our reactor physics section.

These positions are available in our Reactor Engineering Department on the San Francisco peninsula of California.

Please mail complete chronological experience record, including education, salary, earnings history, salary requirements, etc. All replies confidential.

**AMERICAN-STANDARD**
**ATOMIC ENERGY DIVISION**
1682 Broadway Redwood City, Calif.
Dean W. Townsend, Personnel Mgr.

# MECHANICAL ENGINEERING
## OPPORTUNITIES
## in
## ATOMIC ENERGY

**DESIGN**

**TESTING**

**PRODUCTION**

**MAINTENANCE**

**INSTRUMENTATION**

**OPERATIONAL ANALYSIS**

**RESEARCH AND DEVELOPMENT**

**ACTIVITIES**

Design, development, testing, and operation of nuclear reactors and component parts for research, production, power, and aircraft propulsion.

Design and development of pilot and production plants and processes in the over-all atomic energy programs.

Production of barrier and barrier materials, fluorine, and UF6 feed, all directly associated with the concentration of U-235; radioactive and stable isotopes; and special materials required for reactor and other atomic energy programs.

Operation and maintenance of existing facilities.

Fundamental and applied research in the over-all atomic energy programs.

Openings at all Degree Levels, 0–8 years' experience in the

**GASEOUS DIFFUSION PLANTS, OAK RIDGE, TENN. AND PADUCAH, KY.**
**OAK RIDGE, NATIONAL LABORATORY**
**OAK RIDGE Y-12 PLANT**

Exceptional opportunities, modern and unique facilities, liberal benefit plans, educational and training programs, plant interview and moving expenses, moderate climate, year around outdoor recreational activities, low cost living, available housing.

Send resume and salary information to

**TECHNICAL PERSONNEL OFFICE**

## UNION CARBIDE NUCLEAR COMPANY
**a division of**
## UNION CARBIDE AND CARBON CORPORATION

Post Office Box P Oak Ridge, Tennessee

**SEE CHEMSTRAND'S AD on Page 61 of THIS MAGAZINE**

Positions available for

## ENGINEERS

(Chemical, Mechanical, Metallurgical, Textile, Industrial, Instrument and Civil) and

## CHEMISTS

(Organic, Physical, Analytical—Instrumental and Wet Method, Textile Chemists.)

*Write to Technical Personnel Department*

THE
## CHEMSTRAND
CORPORATION
Decatur, Alabama

## engineer

**ME AE EE**

## NUCLEAR AIRCRAFT ENGINE TEST

There is something different about new areas of engineering experience in aircraft nuclear propulsion. Old skills must be adapted to the development of new talents.

At General Electric's ANP Department a career opportunity in the application of atomic energy to aircraft now awaits the qualified engineer.

The position now open is one of importance, involving responsibility for major scale testing program of unique power plant configuration, as well as some design and development work on power plant components. 1 to 3 years' experience in design, development or test of complex, high performance engineer equipment required.

Publication of research results in the appropriate classified or open literature is encouraged.

**Openings in Cincinnati, Ohio and Idaho Falls, Idaho**

*Address replies stating salary requirements to location you prefer*

J. R. Rosselot
P. O. Box 132
Cincinnati, Ohio

L. A. Munther
P. O. Box 535
Idaho Falls, Idaho

GENERAL ELECTRIC

ENGINEERS
AVIONICS
ICBM
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ELECTRONIC RESEARCH is our business
We are permanently dedicated to RESEARCH and DEVELOPMENT in every conceivable field of ELECTRONICS.
GM's long-standing policy of decentralization creates unlimited opportunities for qualified Electrical, Mechanical Engineers and Engineering Technicians.
AC The Electronics Division
GENERAL MOTORS CORP.
COMPUTERS
(Digital and Analog)
MISSILE GUIDANCE
GYRO-SCOPES

New plant (225,000 square feet) now being built in a Milwaukee suburb. This and our present plant will house the ELECTRONICS DIVISION—Milwaukee of the General Motors Corporation.

Your future is assured (if you can qualify) in this lovely cool, southern Wisconsin city where every conceivable living and cultural advantage, plus small town hospitality is yours for the asking. Send full facts today about your education, work background, etc. Every inquiry treated in strict confidence—and you will hear from us by return mail.

**For Employment Application — Mr. John F. Heffinger, Supervisor of Salaried Personnel**

AC THE ELECTRONICS DIVISION
GENERAL MOTORS CORPORATION
Milwaukee 2, Wisconsin Flint 2, Michigan

## CLEVELAND OPPORTUNITIES FOR MECHANICAL ENGINEERS

If you have had professional experience and want to take advantage of increasing opportunities for professional advancement—SEE US:

- **Research**
- **Development**
- **Design**

**in**

**Bearing and Friction Materials**

Conduct studies to expand knowledge of frictional and wear properties of lubricated and unlubricated bearings, washers and seals with emphasis on high speed, high temperature applications.

Please write: E. A. Gentry, Personnel Manager

**CLEVITE RESEARCH CENTER**
**540 East 105th Street**
**Cleveland 8, Ohio**

The Clevite Research Center develops new principles and new products for other units of Clevite Corporation. It is a young organization where good work is quickly recognized. Your professional growth will be accelerated by your association with people from other fields such as physics, electronics and chemistry.

## MACHINE DESIGNERS

**who can meet the challenge of keeping our automatic tube production equipment the most modern in the country!**

Work and live in the ideal surroundings of upstate New York (Elmira) where lovely homes, fine schools and excellent stores are minutes apart. Near famous Finger Lakes year 'round vacation land.

**FIND OUT TODAY about**

opportunities in design of automatic machines for production of electronic tubes. 5 to 10 years' responsible experience in design of medium weight automatic machinery required. Vacuum tube equipment experience desirable but not mandatory.

Telephone collect Elmira 9-3611, or Elmira 9-2360 after 5 or weekends. Or send resume to R. M. Jarrett, P. O. Box 284, Dept. V 23, Elmira, N. Y.

**ONLY YOU!** CAN MAKE THIS IMPORTANT DECISION — Write Now!

Westinghouse
ELECTRONIC TUBE DIV. ELMIRA, N. Y.

*Engineers with Broad Experience*

**Look over the Opportunities in**

## DESIGN ANALYSIS

**at this major company.**

We can't think of a better way for a talented engineer with a broad background to enter the new and growing field of small aircraft engines—gas turbines with a power-weight ratio of more than 4 to 1.

*The assignments are stimulating, and on advanced levels:*

- Analysis of mechanical designs to determine how well they meet performance requirements
- Analysis of the mechanical integrity of designs to ensure their suitability
- Analysis of design concepts and techniques for the purpose of establishing design procedures and criteria
- Study and analysis of stress and vibration characteristics of designs.

You'll have the best facilities in the field at your disposal. Advancement is rapid. Benefits are comprehensive. And you'll enjoy living in this New England resort area.

*Write in strict confidence to:*

**BOX CA-5969,**

**care of "Mechanical Engineering."**

**Opportunities Unlimited**

## ENGINEERING SOCIETIES PERSONNEL SERVICE INC. (AGENCY)

**SECURITY...TOP WAGES... CHALLENGING ASSIGNMENTS**

Qualified Engineers! Thousands of positions available with leading organizations... Employer pays fee in many cases.

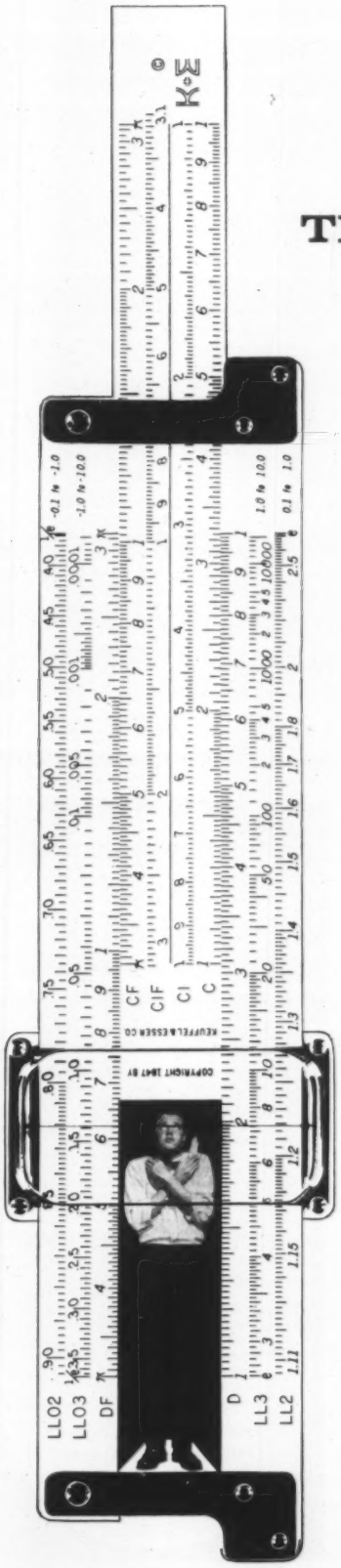
Under the auspices of the Four Founder Engineering Societies and affiliated with other renown Engineering Societies, E.S.P.S. offers many years of placement experience in addition to world wide contacts.

Write for E.S.P.S. weekly Bulletin of Positions Available... See a partial listing of available positions in Personnel Section.

## DON'T DELAY—REGISTER TODAY

**Offices In Major Cities In U. S.**

| New York | Chicago | Detroit | San Francisco |
|---|---|---|---|
| 8 West 40th St. | 84 East Randolph St. | 100 Farnsworth Ave. | 57 Post St. |



# The "petrified" engineer

*He has ability. He has ambition. He has new ideas. But he has a job that gives him only a paycheck. No scope for his ability; no room to move up. He is "petrified" in his present level by lack of promotional opportunity.*

If your career progress has been petrified by lack of opportunity to show what you can do, we think you'll be interested in Lockheed's diversified expansion program.

Forty to fifty projects are in progress continuously. Commercial and military activities span virtually the entire spectrum of aeronautical endeavor. 17 different types of planes are in production today.

There is plenty of room for career-minded engineers to move up at Lockheed—simply because there are so many supervisory positions to be filled with so many projects in motion.

If promotion is of immediate concern to you, why not look into the opportunities presented by Lockheed diversification. It's worth discussing. Write or phone collect, if you possess an engineering degree or actual engineering experience.

Address written inquiries to E.W. Des Lauriers or use the brief résumé form below. If you phone, call STanley 7-1241, Extension 6-2134.

TO ENGINEERS WHO LACK AIRCRAFT EXPERIENCE: Aircraft experience is not necessary to join Lockheed. It's your engineering training and experience that count. Lockheed trains you for aircraft engineering—at full pay.

**Lockheed** AIRCRAFT CORPORATION

*California Division:* BURBANK, CALIFORNIA

E. W. Des Lauriers, Dept. PT-4-11
LOCKHEED AIRCRAFT CORPORATION, BURBANK, CALIFORNIA

Dear Sir: Please send me your brochure detailing life and work at Lockheed.

Name _____

Your field of engineering _____

Home street address _____

City and State _____ Home phone _____

ENGINEERS . . . PHYSICISTS

# NEW opportunities at MOTOROLA

**YOUR CHOICE OF 3 LOCATIONS**

New Motorola research laboratories are expanding, creating outstanding career advantages—your opportunity to get in on the ground floor of a swiftly expanding company. You'll enjoy working in these modern laboratories . . . with liberal employee benefits, including an attractive profit sharing plan. Salary levels are open and commensurate with ability.

**POSITIONS AVAILABLE IN:** two-way communications • missile electronics • radio & TV (color) • weapons systems • computer application & design • transistor research & production • microwave systems • servo-mechanisms • physical chemistry • metallurgical eng. • field eng. • electronic sales eng. • drafting, design, & layout • aerophysics • radar & military electronics

**PHOENIX, ARIZONA**

Outdoor, relaxed living the year-round, with lots of room to grow (on the job and off) in this land of sunshine.

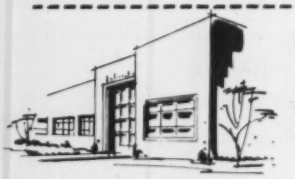
**RESEARCH LABORATORY**
*write to:* **Mr. R. Coulter, Dept. E, 3102 N. 56th St., Phoenix, Ariz.**

**SEMI-CONDUCTOR DIVISION**
*write to:* **Mr. V. Sorenson, Dept. E, 5005 E. McDowell Rd., Phoenix, Ariz.**

**RIVERSIDE, CALIFORNIA**

Planned communities, modern shopping centers, advanced schools, fine buys in homes. There's room to grow and more fun in Riverside.

*write to:* **Mr. C. Koziol, Dept. E, Box 2072, Riverside, Calif.**



**CHICAGO, ILLINOIS**

Live a relaxed midwest life in one of the beautiful suburbs, yet have all the "big city" advantages—cultural, social, and educational.

*write to:* **Mr. L. B. Wrenn, Dept. E, 4501 Augusta Blvd., Chicago, Ill.**

**MOTOROLA**



**SUPERVISOR BASIC METAL PROCESSING RESEARCH**

Attractive, permanent position open in the research laboratories of the world's largest machine tool builder. Mechanical engineer or physicist required, preferably with a doctoral degree, and having strong background in applied mechanics. Should have several years' experience in industrial or academic research in metal processing, and established reputation for original basic research in this field. The laboratory is newly equipped with the finest instrumentation available. Successful candidate will have supervision of a group working on basic research in metal cutting, grinding and metal forming. Will be responsible for planning and directing long-range research in metal processing. Many Company benefits.

*Contact M. Eugene Merchant*
*Assistant Director of Research*

**The Cincinnati Milling Machine Co.**
MARBURG AVE., CINCINNATI 9, OHIO



**ENGINEERS—PHYSICISTS**

**OPPORTUNITIES IN OPERATIONS RESEARCH**

**THE JOHNS HOPKINS UNIVERSITY**

**Operations Research Office**

offers exceptional opportunities for *ENGINEERS* and *PHYSICISTS* who desire the challenge of military operational problems of unusual scope and diversity to routine design and development work.

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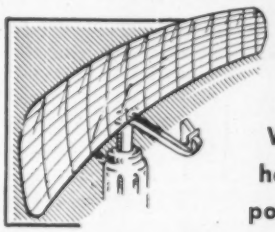

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by Mr. A. W. Robinson — *Manager, Systems Engineering*

**EXPERIMENTS IN HYPERSONICS**
by Dr. Yusuf A. Yoler — *Hypersonic Scientist*

**THE INTEGRATION OF SYSTEMS TEST**
by Mr. William R. Eaton — *Manager, Quality Control and Test Engineering*

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Men with 0-15 years experience in their profession will be considered.

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**It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.**

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Position requires extensive practical power experience including operation and maintenance of industrial steam power plant facilities and equipment testing. Some experience in steam plant design and construction or in thermal insulation of process piping and equipment is desirable. Duties include: making economic evaluations and involved heat balances for complicated power systems; assisting in specification of power equipment and in selection of new facilities; and determination of causes of equipment malfunctioning and development of recommendations for corrections.

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Position requires five or more years' responsible experience on a supervisory or staff level in plant maintenance organizations, planning work, estimating manpower and material requirements, scheduling and controlling work, and accounting for the expenditure of maintenance funds. Successful applicant will consult on preventive and corrective maintenance problems such as: improved procedures and methods, training programs, machine tools and other maintenance equipment, plant maintenance organization, welding, and other related phases of plant maintenance.

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**DEFENSE ELECTRONIC PRODUCTS**

## POSITIONS OPEN

*Continued from Page 188*

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*See advertisements on preceding pages*

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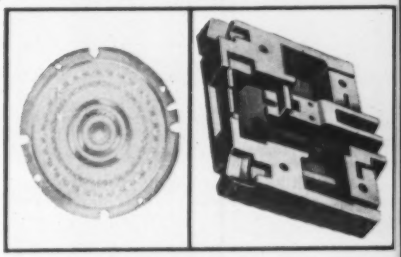

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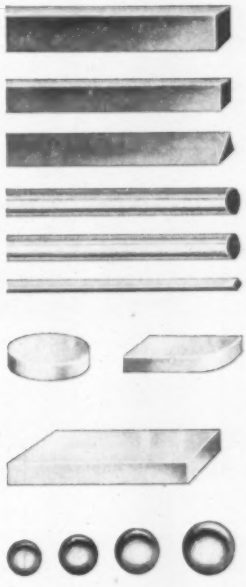
Wollensak Optical Co.
Yoder Co.

## Where can you use these remarkable materials . . .

## KENNAMETAL* and KENTANIUM*?

More than 40 different standard Kennametal compositions have been developed to provide exceptional durability and long life under conditions where any one or a combination of the following destructive forces are met:

- abrasion
- corrosion
- deflection
- deformation
- erosion
- galling
- hard impact or compression
- high temperature (1800°F and above)



Some of the many applications where these hard, strong and rigid sintered carbides are particularly effective in chemical processing include:

- balls for milling
- balls and seats for pumps
- bushings and guides
- compressor liners
- crusher parts
- mixer blades and parts
- nozzles
- pulverizing hammers
- turbine blades, rings, wheels
- valves, valve rings, valve seats

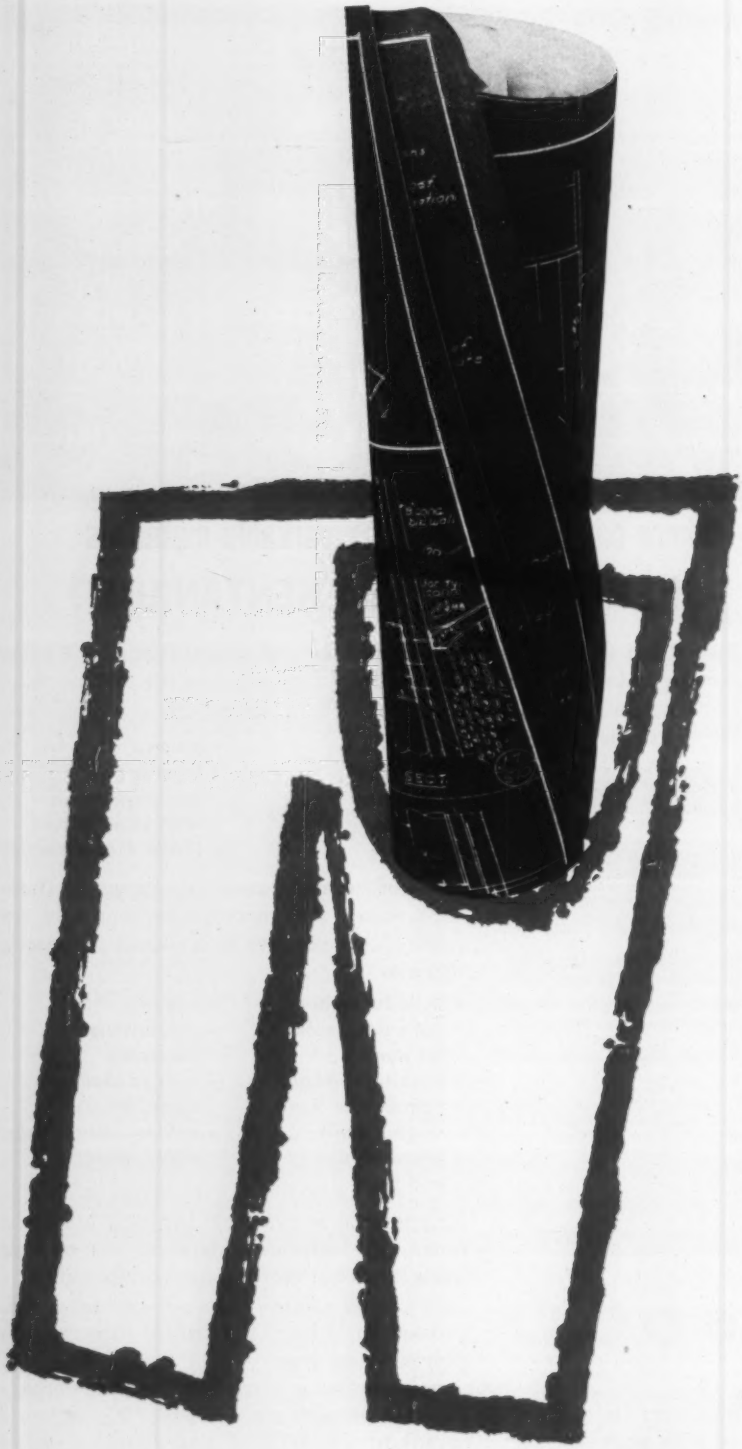
Kennametal is available in many standard forms, in addition to special shapes and parts, such as: rectangular blanks • discs • rods • tubes • flats • balls • rings • extruded, pressed, machined, and ground forms within precise tolerances.

Why not discuss your problems with your Kennametal carbide engineer. He can recommend the proper composition of Kennametal or high heat resistant Kentanium (for 1800° F and above) to meet your specific requirements. Or write KENNAMETAL INC., Latrobe, Pa. For more data, request booklet B-111, *Characteristics of Kennametal*, or B-222, *Designing with Kennametal*.

B-3981

* Trademark of a series of hard tungsten and titanium carbides which have exceptionally high resistance to destructive forces which tend to contaminate chemicals, foods, paints, and other products during processing.

INDUSTRY AND KENNAMETAL
...Partners in Progress



# have an idea in your hip pocket?

Then we have an idea you'll be happiest at Firestone . . . where ideas are most likely to see the light of day and breathe the air of success. Here, too, you'll discover benefits and attitudes inspire more ideas, more success.

Ideas—and men with ideas—have kept Firestone at the top of the pioneers-in-progress list for 56 years. Right now, we're carrying forward the Army's vital program for the "Corporal," first surface-to-surface ballistic guided missile. This includes development engineering, field test and service, and missile and component production.

But the need for good men with good ideas grows . . . because Firestone plans to keep growing in this field. For instance, here are just a few specific needs—a few from a list too long to show in full:

*Component Design*
*Electronics Systems*
*Mechanical Systems*
*Flight Simulation*
*Field Engineering*

There's a man at Firestone with ideas—good ideas—on your future. Why not write today?

Firestone

**GUIDED MISSILE DIVISION**

RESEARCH • DEVELOPMENT • MANUFACTURE

*"Find your Future at Firestone"—Los Angeles • Monterey*

WRITE: SCIENTIFIC STAFF DIRECTOR, LOS ANGELES 54, CALIF.

# SETTING NEW STANDARDS OF PERFORMANCE...

Another LUNKENHEIMER FIRST!

## THE LQ600 VALVE

**FIG. LQ600-200**
200 lb. S.P.—400 lb. W.O.G.
550° F.

**FIG. LQ600-150**
150 lb. S.P.—300 lb. W.O.G.

¼ to 2 inches

Thousands of these valves have served for as long as five years without replacement, regrinding, maintenance, or leakage—even on the most severe services. Their patented Brinalloy* seats and discs are more resistant to wear and corrosion than 500 Brinell Stainless Steel . . . even outlast case-hardened Stainless Steel exceeding 1000 Brinell. LQ600 Valves practically eliminate maintenance costs!

*Patented Alloy—T. M. Reg.

**SEE YOUR LUNKENHEIMER DISTRIBUTOR**
**or write for literature**
**THE LUNKENHEIMER CO., CINCINNATI 14, OHIO**

**LUNKENHEIMER®**
THE ONE *Great* NAME IN VALVES

L-456-28

# New! Completely redesigned milling machine switches spindle to TIMKEN® bearings

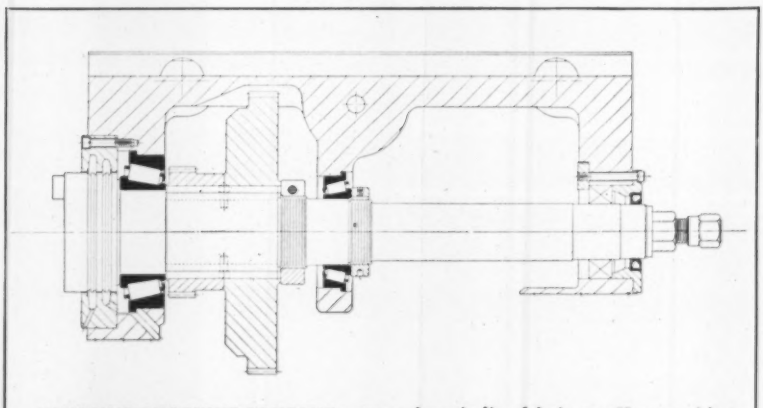
THIS Kempsmith Master-Mill, made by Kempsmith Machine Company, is a brand new, improved model—designed to meet new demands for higher production, lower milling costs. Kempsmith switched to Timken® tapered roller bearings on the new Kempsmith Master-Mill to offer users their many advantages on the spindle, on the table leadscrew, on elevating pinion, and cross feed screw.

Kempsmith reports that Timken bearings are easier to install and adjust, have greater load capacity in small space, are much easier to preload.

Timken bearings hold the spindle in rigid alignment, meeting the requirement of "zero end play over a 24 to 1500 rpm speed range". Tapered construction lets Timken bearings take the radial and thrust loads encountered by a milling machine spindle, in any combination.

Timken bearings were specified, too, because of the heavy shock loads induced by the milling cutter—shocks further amplified by interrupted cuts. Rollers and races in Timken bearings are case-carburized, with tough, shock-resistant cores under hard wear-resistant surfaces. They'll *take* heavy shock loads! And Timken bearings give extra load-carrying capacity with their full line contact between rollers and races.

Geometrically designed for true rolling motion, Timken bearings are precision-manufactured, under rigid quality controls, to conform to their design. We even make our own steel, something no other American bearing maker does. Buying or building machines like this? Look for the trade-mark "TIMKEN" on every bearing! The Timken Roller Bearing Company, Canton 6, Ohio, Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".



**KEMPSMITH MACHINE COMPANY** mounts the spindle of their new Kempsmith Master-Mill milling machine on Timken tapered roller bearings to hold spindle in rigid alignment.

*This symbol on a product means its bearings are the best.*

# TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD